NARRAGANSETT BAY BASIN

WEST WARWICK, RHODE ISLAND

ARCTIC DAM
RI 03802

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY

NEW ENGLAND DIVISION, CORPS OF ENGINEERS

WALTHAM, MASS. 02154

JANUARY 1981

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER RI 03802	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Arctic Dam NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS		5. TYPE OF REPORT & PERIOD COVERED INSPECTION REPORT
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) U.S. ARMY CORPS OF ENGINEERS NEW ENGLAND DIVISION		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS DEPT. OF THE ARMY, CORPS OF ENGINEERS NEW ENGLAND DIVISION, NEDED 424 TRAPELO ROAD, WALTHAM, MA. 02254		12. REPORT DATE January 1981
		13. NUMBER OF PAGES 44
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

APPROVAL FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,
Narragansett Bay Basin
West Warwick Rhode Island
South Branch Pawtuxet River

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The dam is 30 ft. high with a total length of 174 ft. long. It is small in size with a high hazard potential. The dam is considered to be in fair condition. No evidence of instability of the project was observed. There are items which require repair and/or maintenance.

DD FORM 1473 1 JAN 73 EDITION OF 1 NOV 65 IS OBSOLETE

NARRAGANSETT BAY BASIN
WEST WARWICK, RHODE ISLAND

ARCTIC DAM
RI 03802

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

JANUARY 1981

BRIEF ASSESSMENT

PHASE 1 INSPECTION REPORT

NATIONAL PROGRAM OF INSPECTION OF DAMS

Name of Dam:	ARCTIC DAM
Inventory Number:	RI 03802
State:	RHODE ISLAND
County:	KENT
Town:	WEST WARWICK
Stream:	SOUTH BRANCH PAWTUXET RIVER
Owner:	ARCTIC DEVELOPMENT CORPORATION
Date of Inspection:	OCTOBER 8, 1980
Inspection Team:	PETER HEYNEN, P.E.
	HECTOR MORENO, P.E.
	THEODORE STEVENS
	FRANK SEGALINE

Arctic Dam was built around 1885 to generate electricity, but is not presently used for this purpose. The 30 foot high dam has a total length of 174 feet, consisting of a 110 foot long stone masonry spillway centered between two stone masonry and earthfill non-overflow sections. The top of the right non-overflow section is approximately 0.4 foot higher than the top of the left non-overflow section and 5.7 feet above the masonry spillway crest. Permanent stop planks, two feet in height, are mounted on the spillway crest. The low-level outlet for the dam is a 48 inch diameter steel pipe through the left non-overflow section. There are factory buildings adjacent to each end of the dam and masonry walls lining the downstream channel.

In accordance with Army Corps of Engineers' Guidelines, Arctic Dam is classified as a small size, high hazard dam. The test flood range to be considered is from one-half to full Probable Maximum Flood (PMF). The test flood for Arctic Dam is equivalent to the 1/2 PMF. Peak inflow to the impoundment at test flood is 16,500 cubic feet per second (cfs); peak outflow is 16,500 cfs with the dam overtopped by 7.6 feet. The spillway capacity above the permanent stop planks with the reservoir level to the top of the dam is 2200 cfs, which is equivalent to 13% of the routed test flood outflow.

Based upon the visual inspection at the site and past performance, the project is in fair condition. No evidence of instability of the project was observed.

There are items which require repair and/or maintenance, such as the deteriorated low-level outlet, gate, and gate hoisting mechanism, leached out mortar joints on the downstream face of the left non-overflow section, undermining of the wall on the right side of the downstream channel, and brush, saplings and trees growing on the dam and appurtenances.

It is recommended that the owner retain the services of a registered professional engineer to perform a more detailed hydraulic/hydrologic analysis of the existing project discharge capacity. Other items of importance are the restoration of the low-level outlet facilities, repair of leached mortar joints, repair of the undermined channel wall, and removal of trees from the dam and appurtenances.

The above recommendations and further remedial measures presented in Section 7.3 should be implemented within one year of the owner's receipt of this report.

Peter M. Heynen, P.E.
Project Manager - Geotechnical
Cahn Engineers, Inc.

C. Michael Horton, P.E.
Chief Engineer
Cahn Engineers, Inc.

This Phase I Inspection Report on Arctic Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and are hereby submitted for approval.

ARAMAST MAHTESIAN, Member
Geotechnical Engineering Branch
Engineering Division

CARNEY M. TERZIAN, Member
Design Branch
Engineering Division

RICHARD DIBUONO, Chairman
Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRYER
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspection. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam would necessarily represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions will be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions there of. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as neccessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

The Phase I Investigation does <u>not</u> include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

The information contained in this report is based on the limited investigation described above and is not warranted to indicate the actual condition of the dam. The integrity of the dam can only be determined by a means of a monitoring program and/or a detailed physical investigation. The accuracy of available data is assumed where not in obvious conflict with facts observable during the visual inspection.

TABLE OF CONTENTS

	Page
Letter of Transmittal	
Brief Assessment	i, ii
Review Board Signature Page	iii
Preface	iv, v
Table of Contents	vi-viii
Overview Photo	ix
Location Map	x

SECTION 1: PROJECT INFORMATION

1.1 General	1-1
a. Authority	
b. Purpose of Inspection Program	
c. Scope of Inspection Program	
1.2 Description of Project	1-2
a. Location	
b. Description of Dam and Appurtenances	
c. Size Classification	
d. Hazard Classification	
e. Ownership	
f. Operator	
g. Purpose of Dam	
h. Design and Construction History	
i. Normal Operational Procedures	
1.3 Pertinent Data	1-4
a. Drainage Area	
b. Discharge at Damsite	
c. Elevations	
d. Reservoir Length	
e. Reservoir Storage	
f. Reservoir Surface	
g. Dam	
h. Diversion and Regulating Tunnel	
i. Spillway	
j. Regulating Outlets	

SECTION 2: ENGINEERING DATA

2.1 Design Data	2-1
2.2 Construction Data	2-1
2.3 Operation Data	2-1

2.4 Evaluation of Data 2-1

SECTION 3: VISUAL INSPECTION

3.1 Findings 3-1

a. General
b. Dam
c. Appurtenant Structures
d. Reservoir Area
e. Downstream Channel

3.2 Evaluation 3-2

SECTION 4: OPERATIONAL AND MAINTENANCE PROCEDURES

4.1 Operational Procedures 4-1

a. General
b. Description of Warning System in Effect

4.2 Maintenance Procedures....................... 4-1

a. General
b. Operating Facilities

4.3 Evaluation 4-1

SECTION 5: EVALUATION OF HYDRAULIC/HYDROLOGIC FEATURES

5.1 General 5-1

5.2 Design Data 5-1

5.3 Experience Data 5-1

5.4 Test Flood Analysis 5-1

5.5 Dam Failure Analysis 5-1

SECTION 6: EVALUATION OF STRUCTURAL STABILITY

6.1 Visual Observations 6-1

6.2 Design and Construction Data 6-1

6.3 Post Construction Changes 6-1

6.4 Seismic Stability 6-1

SECTION 7: ASSESSMENT, RECOMMENDATIONS & REMEDIAL MEASURES

7.1 Dam Assessment 7-1

a. Condition
b. Adequacy of Information
c. Urgency

7.2 Recommendations 7-1

7.3 Remedial Measures 7-2

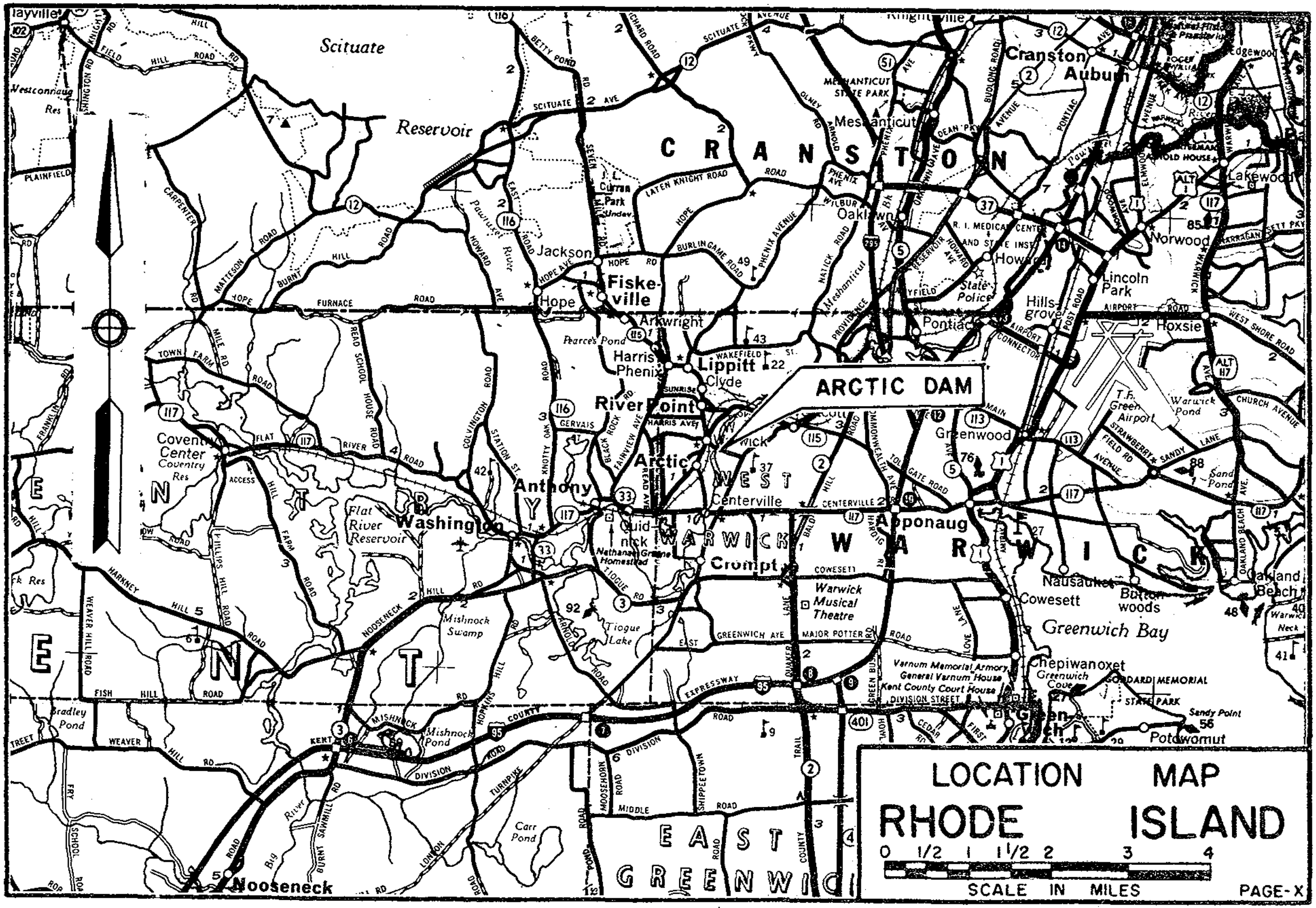
7.4 Alternatives 7-2

APPENDICES

		Page
APPENDIX A:	INSPECTION CHECKLIST	A-1 to A-6
APPENDIX B:	ENGINEERING DATA AND CORRESPONDENCE	
	Dam Plan, Profile and Section	Sheet B-1
	Summary of Data aNd Correspondence	B-1
	Data and Correspondence	B-2 to B-5
APPENDIX C:	DETAIL PHOTOGRAPHS	
	Photograph Location Plan	Sheet C-1
	Photographs	C-1 to C-3
APPENDIX D:	HYDRAULIC/HYDROLOGIC COMPUTATIONS	
	Drainage Area Map	Sheet D-1
	Impact Area Map	Sheet D-2
	Computations	D-1 to D-10
	Preliminary Guidance for Estimating Maximum Probable Discharges	i to viii
APPENDIX E:	INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS	E-1

OVERVIEW PHOTO

US ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.	NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS	Arctic Dam	W. Warwick	DATE Jan. '81 CE # 27 785 KG
CAHN ENGINEERS INC. WALLINGFORD, CONN. ENGINEER		S. Br. Pawtuxet River	Rhode Island	PAGE ix


LOCATION MAP
RHODE ISLAND
0 1/2 1 1 1/2 2 3 4
SCALE IN MILES
PAGE-X
ARCTIC DAM
CRANSTON
WEST WARWICK
WARWICK
COVENTRY
KENT
EAST GREENWIC
Scituate Reservoir
Flat River Reservoir
Greenwich Bay
Tiogue Lake
Mishnock Swamp
Mishnock Pond
Carr Pond
Bradley Pond
Cranston
Auburn
Knightville
Meshanticut
Oaklawn
Howard
Norwood
Lakewood
Edgewood
Lincoln Park
Hillsgrove
Pontiac
Hoxsie
Greenwood
Apponaug
Cowesett
Nausauket
Buttonwoods
Oakland Beach
Chepiwanoxet
Potowomut
Jackson
Hope
Fiskeville
Arkwright
Harris
Phenix
Lippitt
Clyde
River Point
Arctic
Centerville
Crompton
Quidnick
Anthony
Washington
Coventry Center
Nooseneck
T.F. Green Airport
Warwick Musical Theatre
Nathanael Greene Homestead
Varnum Memorial Armory
General Varnum House
Kent County Court House
Goddard Memorial State Park
Sandy Point
State Police
R. I. Medical Center and State Inst.

PHASE I INSPECTION REPORT

ARTIC DAM

SECTION I - PROJECT INFORMATION

1.1 GENERAL

a. Authority - Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Cahn Engineers, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Connecticut. Authorization and notice to proceed were issued to Cahn Engineers, Inc. under a letter of April 14, 1980 from William E. Hodgson, Jr., Colonel, Corps of Engineers. Contract No. DACW 33-80-C-0052 has been assigned by the Corps of Engineers for this work.

b. Purpose of Inspection Program - The purposes of the program are to:

1. Perform technical inspection and evaluation of non-federal dams to identify conditions requiring correction in a timely manner by non-federal interests.

2. Encourage and prepare the States to quickly initiate effective dam inspection programs for non-federal dams.

3. To update, verify and complete the National Inventory of Dams.

c. Scope of Inspection Program - The scope of this Phase I inspection report includes:

1. Gathering, reviewing and presenting all available data as can be obtained from the owners, previous owners, the state and other associated parties.

2. A field inspection of the facility detailing the visual condition of the dam, embankments and appurtenant structures.

3. Computations concerning the hydraulics and hydrology of the facility and its relationship to the calculated flood through the existing spillway.

4. An assessment of the condition of the facility and corrective measures required.

It should be noted that this report passes judgment only on those factors of safety and stability which can be determined by a visual surface examination. The inspection is to identify those visually apparent features of the dam which evidence the need for corrective action and/or further study and investigation.

1.2 DESCRIPTION OF PROJECT

a. Location - The project is located on the South Branch of the Pawtuxet River in an industrial area of the City of West Warwick, County of Kent, State of Rhode Island. The dam is shown on the U.S.G.S. Crompton Quadrangle Map having coordinates latitude N 41°42.4' and longitude W 71°31.3'.

b. Description of Dam and Appurtenances - As shown on Sheet B-1, the 30 foot high dam is a stone-masonry gravity structure probably founded on bedrock for its entire length. The project is approximately 174 feet in length, consisting of a 110 foot long masonry spillway section centered between left and right masonry and earthfill non-overflow sections 42 and 22 feet in length, respectively. The low-level outlet is a 48 inch steel pipe through the left non-overflow section of the dam. Abandoned appurtenances are an old masonry bridge pier near the center of the spillway approach channel, and a filled-in headrace channel at the right end of the dam. Factory buildings are adjacent to both ends of the dam, masonry walls line the downstream channel, and a concrete arch roadway bridge crosses the river approximately 100 feet downstream of the dam.

The factory buildings at each end of the dam have first floor elevations approximately level with the top of the dam. It appears that these buildings are built on embankments which extend slightly in from the original river banks and are contiguous with the dam. The degree to which these structures contribute to the immpoundment of water on the upstream side of the dam is not determined, but for this inspection the exterior walls of the buildings are considered to be the endpoints of the dam; i.e., the length of the dam is equal to the distance between the two buildings.

The spillway is a broad crested masonry weir of trapezoidal cross-section, with permanently attached wooden stop planks. The top of the stop planks, at elevation 108, are approximately 2 feet higher than the masonry spillway crest. The spillway approach channel is shallow and gently sloping with an approximately 20 foot long by 5 foot wide masonry bridge pier near the center of the approach channel. The downstream face of the spillway is tiered and spillway discharge is onto the boulder-strewn natural river bottom. The river banks on each side of the downstream channel, between the dam and the roadway bridge consist of approximately 30 foot high vertical masonry retaining walls, with 5 to 8 foot wide benches at mid-height.

The right and left non-overflow sections of the dam each consist of upstream, downstream, and spillway-facing vertical masonry walls and a center earthfill. The masonry faces adjacent to each end of the spillway serve as training walls, the downstream faces connect to the retaining walls on each side of the downstream channel, and the upstream face of the right non-overflow section connects to the old headrace channel. The top of the left non-overflow section is the low point of the top of the dam. At elevation 111.3, it is 3.3 feet higher than the top of the stop planks and 0.4 foot lower than the top of the right non-overflow section.

A rack-with-pinion gate hoist is located on the top of the upstream masonry wall near the left end of the dam. The gate controls flow through a 48 inch diameter steel pipe which exits at invert elevation 93.8± from the downstream face of the left non-overflow section. The type and size of the gate are not known, but judging from the operating mechanism, it is probably a sluice gate.

c. Size Classification - (SMALL) - The dam is approximately 30 feet in height and with the upstream water level to the top of the dam, it impounds approximately 230 acre-feet of water. According to recommended guidelines, a dam between 25 and 40 feet in height and with a storage capacity between 50 and 1000 acre-feet is classified as small in size.

d. Hazard Classification - (HIGH) -If the dam were breached, there is potential for extensive property damage and economic loss as well as potential for loss of more than a few lives at industrial buildings located approximately 2500 and 3900 feet downstream of the dam. A breach of the dam could cause these buildings to be rapidly innundated with as much as 5 feet of water.

e. Ownership - Arctic Development Corporation
33 Factory Street
West Warwick, Rhode Island
Mr. Robert Galkin, President
Mr. Warren Galkin, Vice President
(401) 828-0300

The present owner purchased the dam from American Tourister Company in 1960. Westover Fabric Company was an earlier owner.

f. Operator - The owners are responsible for the operations of the project.

g. Purpose of Dam - Although the dam is not presently in use, a feasibility study to restore its hydroelectric generation capabilities is in progress.

h. Design and Construction History - Very little is known of the design and construction of the project. It is estimated that the dam was built around 1885. Originally there was a bridge across the spillway approach channel. The bridge was later removed but the date of removal is not known. The power generation facilities were shut down sometime before 1960 and the headrace channel filled around 1972.

i. Normal Operational Procedures - It appears that the low-level outlet for the dam is kept in a closed position and normal flow is over the stop planks. However, observed flow from the pipe indicates that the gate is not closed tightly or that it leaks, or possibly that there is seepage from the body of the dam into the pipe. No formal operational procedures exist.

1.3 PERTINENT DATA

a. Drainage Area - The drainage area is 73.4 square miles of largely undeveloped to heavily developed, flat and coastal terrain including large swamps. Significant upstream impoundments are Tiogue Lake, Stump Pond, Flat River Reservoir and Quidnik Reservoir.

b. Discharge at Damsite - Discharge is over the spillway and through the low-level outlet.

1. Outlet Works (conduits) 48 inch diameter steel low-level outlet pipe @ invert el. 93.8±:	280 cfs (upstream water level at top of dam)
2. Maximum known flood at damsite:	Since 1960 to about 1 foot below top of right non-overflow section (See Section 5.3)
3. Ungated spillway capacity @ top of dam el. 111.3:	2200 cfs
4. Ungated spillway capacity @ test flood el. 118.9:	13,100 cfs
5. Gated spillway capacity @ normal pool:	N/A
6. Gated spillway capacity @ test flood:	N/A
7. Total spillway capacity @ test flood el. 118.9:	13,100 cfs
8. Total project discharge @ top of dam el. 111.3:	2,480 cfs
9. Total project discharge @ test flood el. 118.9:	16,500 cfs

c. Elevations - Elevations are on National Geodetic Vertical Datum (NGVD), based on an assumed elevation of 108.0 at the top of the stop planks, corresponding to the upstream water level shown on the USGS Crompton Quadrangle Map, 1970.

1. Streambed at toe of dam:	81.7±
2. Bottom of cutoff:	Not Known

3. Maximum tailwater:	Not known
4. Normal pool:	108.0
5. Full flood control pool:	N/A
6. Spillway crest (ungated)	
Top of stop planks:	108.0 (assumed datum)
Masonry crest:	106.0
7. Design surcharge (original design):	Not known
8. Top of dam:	111.3$\pm$
9. Test flood surcharge:	118.9

d. Reservoir Length

1. Normal pool:	2300$\pm$ ft.
2. Flood control pool:	N/A
3. Spillway crest pool: (top of stop planks)	2300$\pm$ ft.
4. Top of dam pool:	2400$\pm$ ft.
5. Test flood pool:	3500$\pm$ ft.

e. Reservoir Storage

1. Normal pool:	175$\pm$ acre-ft.
2. Flood control pool:	N/A
3. Spillway crest pool: (top of stop planks)	175$\pm$ acre-ft.
4. Top of dam pool:	230$\pm$ acre-ft.
5. Test flood pool:	425$\pm$ acre-ft.

f. Reservoir Surface

1. Normal pool:	12$\pm$ acres
2. Flood control pool:	N/A
3. Spillway crest pool: (Top of stop planks)	12$\pm$ acres
4. Top of dam pool:	17$\pm$ acres

5. Test flood pool:	28± acres

g. Dam

1. Type:	Stone masonry gravity and earthfill
2. Length:	174 ft.
3. Height:	30 ft.
4. Top width:	70± ft.
5. Side slopes:	Vertical
6. Zoning:	Upstream and downstream masonry walls with center earthfill
7. Impervious core:	N/A
8. Cutoff:	Not known
9. Grout curtain:	N/A
10. Other:	Adjacent factory buildings close overflow profile

h. Diversion and Regulating Tunnel - N/A

i. Spillway

1. Type:	Broad-crested masonry weir with 2 feet high permanent stop planks
2. Length of weir:	110 ft.
3. Crest elevation:	108.0-top of stop planks 106.0-masonry crest
4. Gates:	N/A
5. Upstream channel:	Shallow, gravel bottom
6. Downstream channel:	Bouldery river bed with masonry retaining walls
7. General:	Tiered downstream face. Bridge pier in approach channel

j. Regulating Outlets

Low-level outlet

1. Invert	93.8$\pm$
2. Size:	48 inch diameter
3. Description:	Steel pipe
4. Control mechanism:	Rack with pinion gate hoist
5. Other:	Operability questionable Location of handle unknown

SECTION 2: ENGINEERING DATA

2.1 DESIGN DATA

The available data consists of inventory data by the State of Rhode Island and inspection reports dated March 27, 1946 and September 11, 1978 by the State of Rhode Island (See Appendix B).

2.2 CONSTRUCTION DATA

No information is available.

2.3 OPERATIONS DATA

According to the 1946 inspection report a river gage was read every hour daily from 7 A.M. to 11 P.M. These records were not available.

2.4 EVALUATION OF DATA

a. Availability - Available data was provided by the State of Rhode Island and the owner. The owner made the project available for visual inspection.

b. Adequacy - The limited amount of detailed engineering data available was generally inadequate to perform an in-depth assessment of the dam, therefore, the final assessment of this dam must be based primarily on visual inspection, performance history, hydraulic computations of spillway capacity and hydrologic estimates.

c. Validity - A comparison of record data and visual observations reveals no significant discrepancies in the record data.

SECTION 3: VISUAL INSPECTION

3.1 FINDINGS

a. General - The general condition of the project is fair. The inspection revealed several areas in need of maintenance. At the time of inspection the upstream water level was at elevation 108.2±, with approximately 2 inches of water flowing over the stop planks and masonry spillway.

b. Dam

Top of Dam - The top of the right non-overflow section is in good condition, with a regular surface and good grass cover (Photo 1). A wooden railing on top of the masonry wall and extending from the upstream edge of the dam to the bridge 100 feet downstream of the dam is in fair condition, with slight rotting of the wood.

The top of the left non-overflow section is in poor condition with a dense growth of small trees, saplings and underbrush and several footpaths due to trespassing (Overview Photo).

Upstream Face - The upstream faces of both the right and left non-overflow sections are in good condition with no displacement of masonry and only minor leaching and cracking of the mortar joints.

Downstream Face - The downstream face of the right non-overflow section is in good condition. No leaching or cracking of mortar joints or displacement of masonry was observed.

The downstream face of the left section is in poor condition. In the area beneath the low-level outlet pipe, mortar has been almost totally leached out of the joints in the masonry (Photo 2). This appears to be caused by leakage from the pipe onto the outside of the wall, rather than by seepage from the body of the dam through the wall. A clump of small trees, the roots of which may extend through the masonry face into the body of the dam, is growing on top of the outlet pipe where it exits from the dam. Other than in the area of the outlet pipe, the downstream face appears to be in good condition, although the toe is obscured by branches and debris.

Spillway - Although it appears to be in good condition, flow over the spillway prevented close inspection of the downstream face and toe. No irregularities of the tiered downstream face were noted and the abutments with the non-overflow sections appeared good, except for some leaching of mortar due to contact with water going over the spillway. The masonry spillway crest appears to be in good condition, but the stop planks are somewhat leaky and deteriorated. The stop plank supports, though rusted on the outside, do not show any significant deterioration. Also, at approximately 4 feet apart, they are closely spaced, and all are in place. Other than the old bridge pier, from which several small trees are growing, there are no obstructions in the spillway approach channel. At the time of inspection, there was an accumulation of debris at the crest of the stop planks, 3 logs resting on the downstream face of the spillway, and various floating objects collected on the rocks at the toe of the spillway (Overview Photo, Photo 3).

c. Appurtenant Structures - The operability of the low-level outlet gate for the dam is questionable and the 48 inch steel low-level outlet pipe appears to be in poor condition. The control mechanism, a rack-with-pinion gate hoist mounted on the upstream wall of the left non-overflow section, is rusted and the wood gate support is rotting (Photo 4). The handle for the control mechanism is not in place and the owner is not sure of its location. Approximately 200 gallons per minute (gpm) or more were flowing from the downstream end of the low-level outlet pipe (Photo 2), indicating that either the gate leaks or that it is not tightly closed, or possibly that there is seepage from the body of the dam into the pipe. Observed from its downstream end, the pipe is in poor condition. Although it protrudes approximately 5 feet out from the downstream face of the dam, extensive corrosion of the bottom of the pipe allows some of the flow through the pipe to be discharged onto the masonry face of the dam, causing leaching of the mortar. Also, as previously mentioned, there is a clump of small trees growing on top of the pipe at its point of exit from the dam.

The factory buildings at each end of the dam appear to be in good condition, with no notable signs of deterioration. The old tailrace channel under the factory to the right of the dam is filled in and now serves as a parking area. There were no observable problems in this area.

d. Reservoir Area - The reservoir has steep-sided, wooded banks and the land at the top of the banks is heavily developed.

e. Downstream Channel - The downstream channel is broad and deep, although the normal flow is shallow. The channel bottom is bouldery and the channel sides are masonry walls for about 100 feet to the bridge. Brush and small trees are growing from the benches of the walls on either side of the river and it appears that the right side wall is being undermined (Photos 5 and 6). The concrete arch bridge appears to be in good condition and does not appear to constrict the river channel.

3.2 EVALUATION

Based upon the visual inspection, the project is in fair condition. The manner in which the features identified in Section 3.1 could affect the future condition and/or stability of the project is as follows.

1. The root systems of the small trees on the left non-overflow section could provide paths for seepage through the dam, especially if they are allowed to grow to be large

trees. Also, they could be uprooted, causing damage to the dam.

2. The footpaths on the left non-overflow section are susceptible to erosion should this portion of the dam be overtopped.

3. The downstream masonry wall of the left non-overflow section could be weakened by leaching of the mortar joints.

4. Roots of the clump of small trees growing on top of the low-level outlet pipe could further penetrate the adjacent downstream wall of the dam, causing displacement of masonry.

5. Branches and debris at the toe of the left non-overflow section prevent close inspection of this area.

6. Further leaching of mortar joints of the masonry walls adjacent to each end of the spillway could weaken these walls.

7. Small trees growing on the masonry pier in the spillway approach channel could reduce the spillway capacity, especially if allowed to grow to be large trees.

8. If the low-level outlet gate is inoperable, it prevents lowering of the upstream water level should the need occur.

9. Continued rusting of the low-level outlet pipe along with possible leakage of the outlet gate could cause water to leak from the pipe into the body of the dam, possibly causing internal erosion of the dam.

10. The roots of brush and trees growing from the walls on each side of the downstream channel could cause displacement of masonry.

11. Undermining of the masonry wall along the right side of the downstream channel could threaten the stability of this wall.

SECTION 4: OPERATIONAL AND MAINTENANCE PROCEDURES

4.1 OPERATIONAL PROCEDURES

a. General - Lake level readings are not taken and no regulating procedures are followed at the dam.

b. Description of Any Warning System in Effect - No formal downstream warning system is in effect.

4.2 MAINTENANCE PROCEDURES

a. General - Other than the regular cutting of grass on the right non-overflow section, and periodic removal of debris from the area of the spillway, there is no formal program of maintenance. The dam was inspected in September, 1978 by the State of Rhode Island Department of Environmental Management.

b. Operating Facilities - No formal program for maintenance of the operating facilities is in effect. It is not known when the low-level outlet gate was last operated.

4.3 EVALUATION

The operation and maintenance procedures are generally poor. A formal program of operations and maintenance procedures should be implemented, including documentation to provide complete records for future reference. Also, a formal warning system should be developed and implemented within the time frame indicated in Section 7.1c. Remedial operation and maintenance recommendations are presented in Section 7.3.

SECTION 5: EVALUATION OF HYDRAULIC/HYDROLOGIC FEATURES

5.1 GENERAL

The Arctic Dam watershed is 73.4 square miles of flat and coastal wooded terrain, typically containing large swamps and impoundments (Tiogue Lake, Stump Pond, Flat River and Quidnick Reservoirs) which contribute to the sluggish runoff characteristics of the watershed.

The dam is a masonry and earthfill dam with a masonry spillway. It is basically a low surcharge storage - high spillage type project. The reservoir area of approximately 12 acres is small in relation to the drainage area and consequently, the surcharge storage of the project is too small to have an appreciable effect in reducing the ½ PMF outflow of 16,500 cubic feet per second (cfs).

5.2 DESIGN DATA

No computations could be found for the original design of the dam.

5.3 EXPERIENCE DATA

The owner reports that since 1960, the highest observed water level was approximately 1 foot below the top of the right non-overflow section. This water level is about ½ foot below the first point of overtopping of the left non-overflow section and may correspond to the flow of 2,000 cfs recorded on the river in 1968.

5.4 TEST FLOOD ANALYSIS

Based upon the watershed classification (Flat and Coastal), and the watershed area of 73.4 square miles; and utilizing the guide curve (Appendix D, p. v) in the U.S. Army Corps of Engineers "Preliminary Guidance for Estimating Maximum Probable Discharges", a PMF of 33,000 cfs or 450 cfs per square mile is estimated at the damsite. In accordance with the size (small) and hazard (high) classification, the range of test floods to be considered is from the ½ PMF to the PMF. Based on the degree of hazard associated with a breach of the dam, the test flood for Arctic Dam is equivalent to the ½ PMF. The pond level at the start of the test flood is considered to be at the top of the stop planks at elevation 108.0. The peak outflow for the test flood is estimated at 16,500 cfs and this flow will overtop the dam by 7.6 feet. Based on hydraulics computations, the spillway capacity above the stop planks to the top of the dam is 2,200 cfs which is equivalent to 13% of the routed test flood outflow (Appendix D-4).

5.5 DAM FAILURE ANALYSIS

Upon failure of Arctic Dam, the downstream impact area consists of two industrial buildings located 2500 and 3900 feet downstream of Arctic Dam. Both of these buildings are constructed adjacent to dams and portions of both buildings extend along the upstream impoundments as well as along the downstream discharge channels of their respective dams. At each location, the first floor elevation of the portion of the building upstream of the dam is approximately level with the top of the dam and 5 feet above the spillway crest. On the downstream side of each dam, the elevation above the spillway discharge channel of the first floors of these buildings is 7 feet at the upper dam and 11 feet at the lower dam.

The dam failure analysis is based on the April, 1978 Army Corps of Engineers "Rule of Thumb Guidance for Estimating Downstream Dam Failure Hydrographs". With the pond level at the top of the dam, peak outflow before failure of the dam would be about 2,200 cfs and the peak failure outflow from the dam breaching would total about 18,300 cfs.

Prior to failure of Arctic Dam the depth of flow over the spillway at the upper of the two downstream impoundments would be approximately 3.2 feet, or 1.8 feet below the first floor elevation of the adjacent building. Failure of Arctic dam would result in a 6.7 foot increase in water level to a depth of 9.9 feet above the spillway crest. This rapid increase in water level will innundate the building by approximately 4.9 feet.

At the spillway of the lower downstream impoundment, the prefailure flow depth would be approximately 3.6 feet, or 1.4 feet below the first floor elevation of the adjacent building. Failure of Arctic Dam would result in a 5.1 foot increase in water level to a depth of 8.7 feet above the spillway crest, innundating the building by approximately 3.7 feet.

Innundation of portions of these buildings has the potential to cause economic losses and the loss of more than a few lives. Therefore, Arctic Dam is classified as a high hazard dam (Appendix D-9).

SECTION 6: EVALUATION OF STRUCTURAL STABILITY

6.1 VISUAL OBSERVATIONS

The dam is a masonry gravity structure and appears to be founded on bedrock. The configuration of the upstream face of the spillway is not known and the downstream face is tiered, giving the masonry spillway section a base width of at least 15 feet, if the upstream face is vertical. The non-overflow sections of the dam have vertical masonry walls around their perimeters and inner earthfill. The masonry walls have top widths of approximately 3 feet, but their base widths are not known. Although several design features are not known, there are no visual indications of a structurally unstable design.

The areas of deterioration described in Section 3 are not considered to be stability concerns at the present time. However, if left unchecked, leaching of mortar joints and leakage from the low-level outlet pipe could cause instability of the left non-overflow section, and continued undermining of the masonry wall along the right side of the downsteam channel could cause it to become unstable.

6.2 DESIGN AND CONSTRUCTION DATA

No information is available.

6.3 POST-CONSTRUCTION CHANGES

Post-construction changes to the project include filling of the headrace channel at the right end of the dam and removal of a bridge across the spillway approach channel. Neither of these changes appears to affect the stability of the structure. No other post-construction changes are known.

6.4 SEISMIC STABILITY

The project is located near the boundary between Seismic Zones 1 and 2 and, according to U.S. Army Corps of Engineers Recommended Guidelines, need not be evaluated for seismic stability.

SECTION 7: ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Condition - Based upon the visual inspection of the site and past performance, the dam is in fair condition. No evidence of immediate structural instability was observed in the dam or appurtenances; however, there are areas which require repair and/or maintenance.

Based upon the Army Corps of Engineers' "Preliminary Guidance for Estimating Maximum Probable Discharges" dated March, 1978, the watershed classification and hydraulic/hydrologic computations, peak inflow to the pond at test flood is 16,500 cubic feet per second (cfs); peak outflow is 16,500 cfs with the dam overtopped 7.6 feet. Based upon our hydraulic computations, the spillway capacity to the top of dam is 2200 cfs, which is equivalent to approximately 13% of the routed test flood outflow. This indicates an inadequate spillway capacity.

b. Adequacy of Information - The information available is such that an assessment of the condition and stability of the project must be based solely on visual inspection, past performance and sound engineering judgement.

c. Urgency - It is recommended that the measures presented in Section 7.2 and 7.3 be implemented within one year of the owner's receipt of this report.

7.2 RECOMMENDATIONS

It is recommended that further studies pertaining to the following items be made by a registered professional engineer qualified in dam design and inspection. Recommendations made by the engineer should be implemented by the owner.

1. A detailed hydraulic/hydrologic analysis to determine the adequacy of the project discharge capacity and overtopping potential.

2. Inspection of the downstream face and toe of the spillway section with the upstream water level just below the spillway crest.

3. Inspection of the inside of the 48 inch steel low-level outlet pipe, determination of the source of leakage through the pipe, and repair or replacement of the pipe.

4. Determination of the cause of leaching of the mortar from joints in the masonry, particularly near the low-level outlet pipe's exit from the downstream face of the dam and repair of the mortar joints.

5. Repair or replacement of the low-level outlet gate and gate hoisting mechanism.

6. Repair of undermined areas of the masonry wall along the right side of the downstream channel.

7. Removal of all trees from the dam and from within 10 feet of the toe of the dam, including proper backfilling with selected material.

7.3 REMEDIAL MEASURES

Operation and Maintenance Procedures - The following measures should be undertaken by the owner within the length of time indicated in Section 7.1.c, and continued on a regular basis.

1. Round-the-clock surveillance should be provided during periods of heavy precipitation or high project discharge. A formal downstream warning system should be developed to be used in case of emergencies at the dam.

2. A formal program of operation and maintenance procedures should be instituted and fully documented to provide accurate records for future reference.

3. A comprehensive program of inspection by a registered professional engineer qualified in dam inspection should be instituted on an annual basis.

4. Brush and saplings should be removed from the dam and appurtenant structures and from within 10 feet of the toe of the dam.

5. Grass cover should be established on the left non-overflow section.

6. Branches and debris should be removed from an area extending to approximately 10 feet from the toe of the left non-overflow section so that the toe can be inspected.

7. Leached or cracked mortar joints on the dam and appurtenant structures should be repaired and maintained as part of normal maintenance procedures at the site.

8. The practice of clearing debris from the spillway crest, from the downstream face of the spillway, and from the toe of the spillway should be continued as part of normal maintenance procedures at the site.

9. The rotted wooden railing along the top of the right non-overflow section should be repaired.

7.4 ALTERNATIVES

This study has identified no practical alternatives to the above recommendations.

APPENDIX A

INSPECTION CHECKLIST

VISUAL INSPECTION CHECK LIST

PARTY ORGANIZATION

PROJECT Arctic Dam

DATE: Oct. 8, 1980

TIME: 9:30 am

WEATHER: Fair 50°

W.S. ELEV. 1082± U.S. 82.0± DN.S

PARTY:	INITIALS:	DISCIPLINE:
1. Peter Heynen	PH	Geotechnical
2. Theodore Stevens	TS	Geotechnical
3. Hector Moreno	HM	Hydraulics
4. Frank Segeline	FS	Survey
5.		
6.		

PROJECT FEATURE	INSPECTED BY	REMARKS
1. Right Non-overflow Section	TS, PH, HM	
2. Left Non-overflow Section	TS, PH, HM	
3. Intake Structure	TS, PH, HM	
4. Low-level Outlet	TS, PH, HM	
5. Spillway	TS, PH, HM	
6.		
7.		
8.		
9.		
10.		
11.		
12.		

PERIODIC INSPECTION CHECK LIST

Page A-2

PROJECT Arctic Dam DATE 10-8-80

PROJECT FEATURE Right Non-overflow Section BY TS, PH, HM

AREA EVALUATED		CONDITION
DAM EMBANKMENT		
Crest Elevation		111.7±
Current Pool Elevation		108.2±
Maximum Impoundment to Date		110.4± (since 1960)
Surface Cracks		None observed
Pavement Condition		N/A
Movement or Settlement of Crest		None observed
Lateral Movement		None observed
Vertical Alignment		Appears good
Horizontal Alignment		Appears good
Condition at Abutment and at Concrete Structures		Appears good-at building
Indications of Movement of Structural Items on Slopes		N/A
Trespassing on Slopes		N/A
Sloughing or Erosion of Slopes or Abutments		None observed
Rock Slope Protection-Riprap Failures		N/A
Unusual Movement or Cracking at or Near Toes		None observed
Unusual Embankment or Downstream Seepage		None observed
Piping or Boils		None observed
Foundation Drainage Features		N/A
Toe Drains		N/A
Instrumentation System		N/A

PERIODIC INSPECTION CHECK LIST

Page A-3

PROJECT Arctic Dam DATE 10-8-80

PROJECT FEATURE Left Non-overflow Section BY TS, PH, HM

AREA EVALUATED	CONDITION
DAM EMBANKMENT	
Crest Elevation	111.3 ±
Current Pool Elevation	108.2 ±
Maximum Impoundment to Date	110.4 ± (since 1960)
Surface Cracks	None observed
Pavement Condition	N/A
Movement or Settlement of Crest	None observed
Lateral Movement	None observed
Vertical Alignment	Appears good
Horizontal Alignment	Appears good
Condition at Abutment and at Concrete Structures	Appears good - at building
Indications of Movement of Structural Items on Slopes	N/A
Trespassing on Slopes	Footpaths on top
Sloughing or Erosion of Slopes or Abutments	None observed
Rock Slope Protection-Riprap Failures	N/A
Unusual Movement or Cracking at or Near Toes	Toe obscured by debris
Unusual Embankment or Downstream Seepage	Seepage through low-level outlet onto D/S face of dam causing leaching of joints
Piping or Boils	None observed
Foundation Drainage Features	N/A
Toe Drains	N/A
Instrumentation System	N/A

PERIODIC INSPECTION CHECK LIST

Page A-4

PROJECT Arctic Dam DATE 10-8-80

PROJECT FEATURE Intake Structure BY TS, PH, HM

AREA EVALUATED		CONDITION
OUTLET WORKS-INTAKE CHANNEL AND INTAKE STRUCTURE		
a) Approach Channel		Approach channel under water - could not observe
Slope Conditions		
Bottom Conditions		
Rock Slides or Falls		
Log Boom		
Debris		
Condition of Concrete Lining		
Drains or Weep Holes		
b) Intake Structure		
Condition of Concrete		Masonry intact - no deterioration
Stop Logs and Slots		Gate-hoisting mechanism (rack-with-pinion) in poor condition - rusted steel, rotting wood. Location of handle not known

PERIODIC INSPECTION CHECK LIST

Page A-5

PROJECT Arctic Dam DATE 10-8-80

PROJECT FEATURE Low-level Outlet BY TS, PH, HM

AREA EVALUATED		CONDITION
OUTLET WORKS-OUTLET STRUCTURE AND OUTLET CHANNEL		
General Condition of Concrete		Masonry - fair condition - leaching of mortar joints
Rust or Staining		Severe rusting of 48" pipe
Spalling		N/A
Erosion or Cavitation		None observed
Visible Reinforcing		N/A
Any Seepage or Efflorescence		None observed
Condition at Joints		Poor - leached out
Drain Holes		N/A
Channel		
Loose Rock or Trees Overhanging Channel		Many small trees near outlet
Condition of Discharge Channel		N/A - Discharge almost directly to D/S channel

PERIODIC INSPECTION CHECK LIST

Page A-6

PROJECT Arctic Dam

DATE 10-8-80

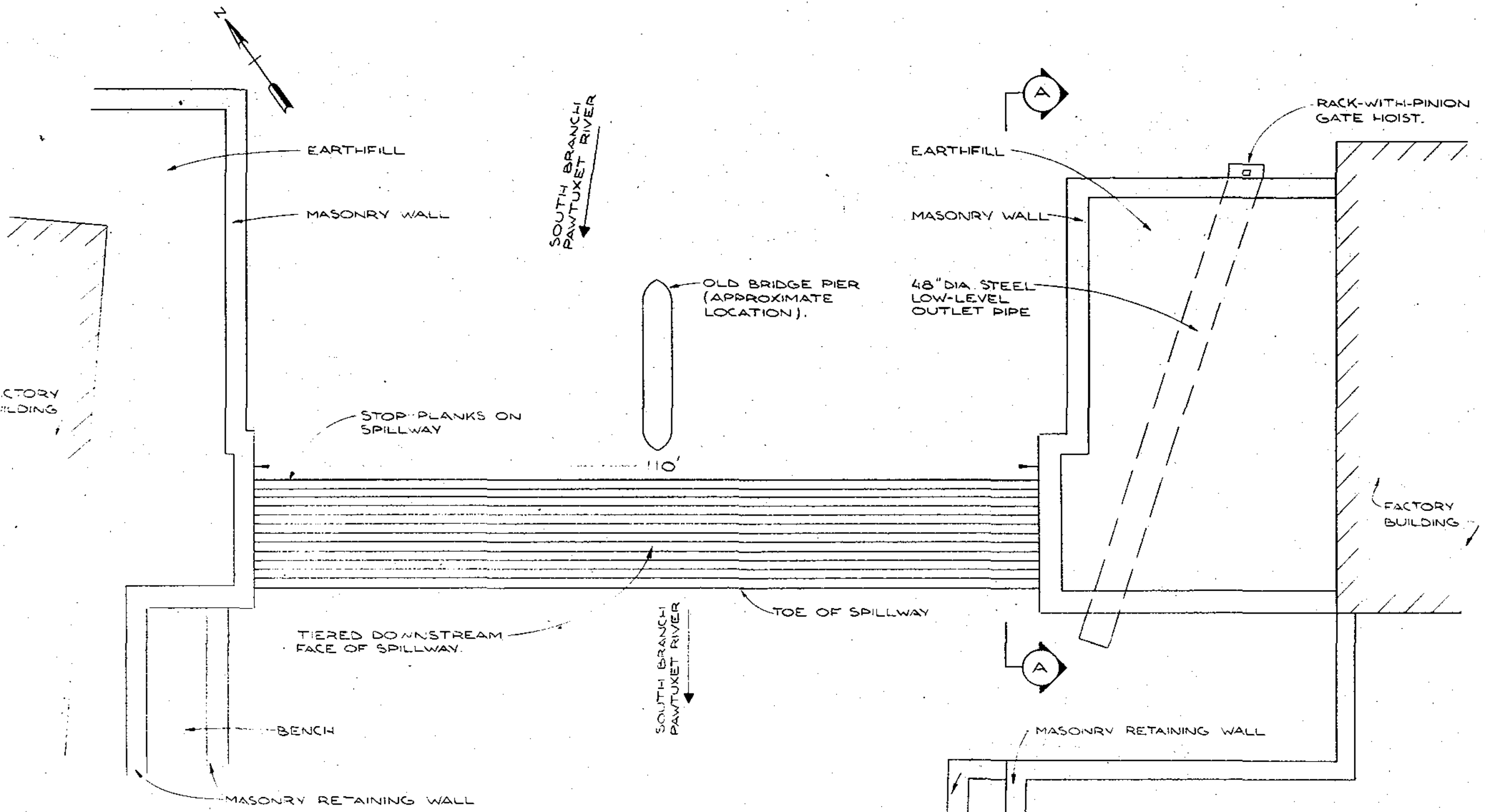
PROJECT FEATURE Spillway

BY TS, PH, HM

AREA EVALUATED		CONDITION
OUTLET WORKS-SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS		
a) Approach Channel		
General Condition		Good
Loose Rock Overhanging Channel		No
Trees Overhanging Channel		Small trees on pier
Floor of Approach Channel		Shallow, sandy
b) Weir and Training Walls		
General Condition of ~~Concrete~~ Masonry		Good
Rust or Staining		Minor staining of walls-from spray
Spalling		None observed
Any Visible Reinforcing		N/A
Any Seepage or Efflorescence		None observed
Drain Holes		N/A
c) Discharge Channel		
General Condition		Shallow, broad, bouldery
Loose Rock Overhanging Channel		No
Trees Overhanging Channel		Minor
Floor of Channel		Boulders
Other Obstructions		None observed

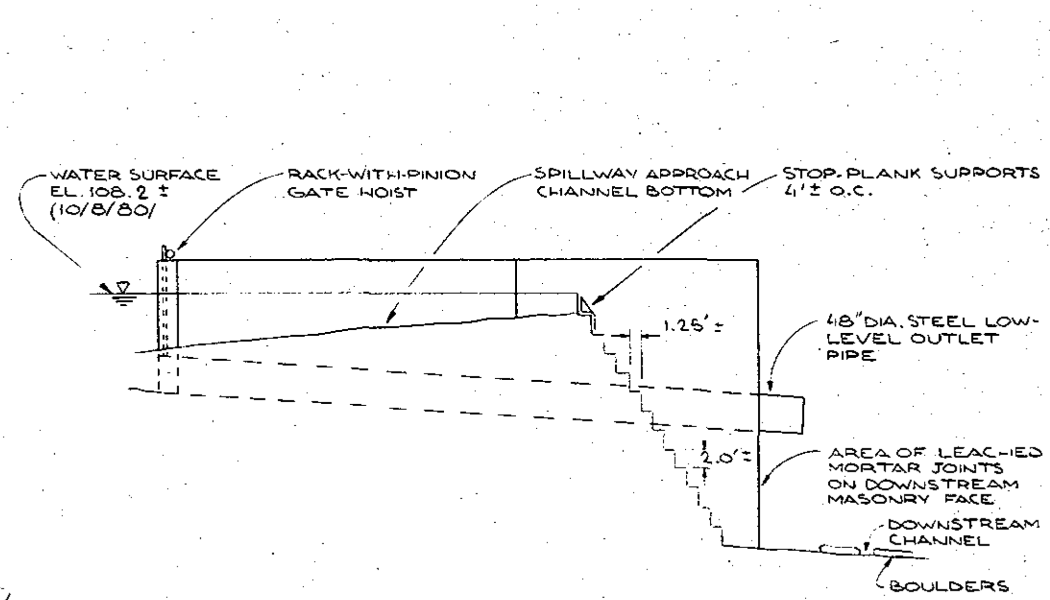
APPENDIX B

ENGINEERING DATA AND CORRESPONDENCE



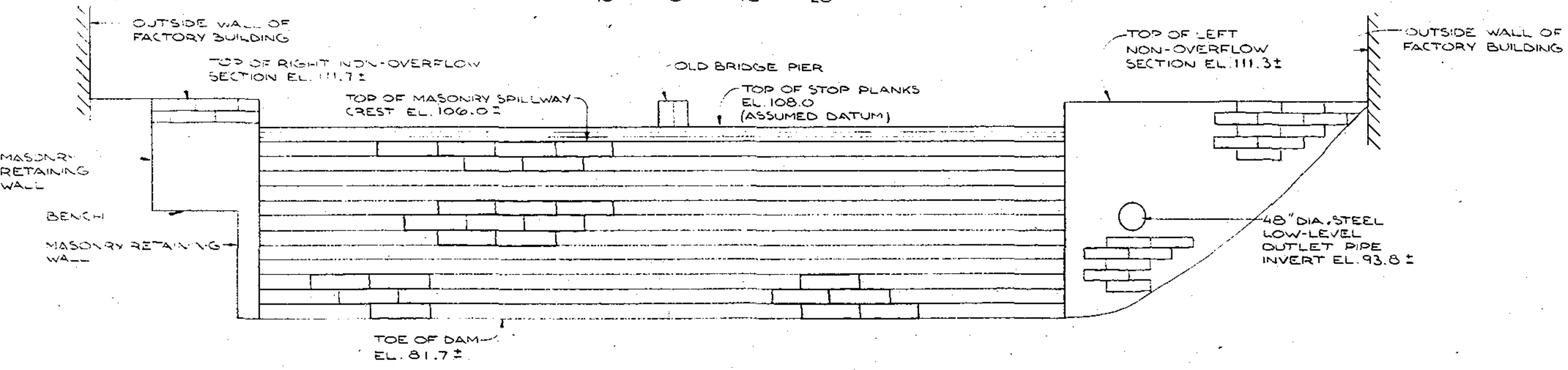
PLAN.

10' 0' 10' 20'



SECTION A - A

10' 0' 10' 20'



ELEVATION.

10' 0' 10' 20'

NOTES:

1. THIS PLAN WAS COMPILED FROM CAHN ENGINEERS INSPECTION OF THE DAM ON OCTOBER 8, 1980. DIMENSIONS SHOWN ARE APPROXIMATE. NOT ALL TOPOGRAPHIC AND/OR STRUCTURAL FEATURES ARE NECESSARILY IDENTIFIED.
2. NO ELEVATIONS WERE AVAILABLE FOR THE DAM, THEREFORE, THE WATER SURFACE ELEVATION OF 108 FOR THE IMPOUNDMENT SHOWN ON THE U.S.G.S. CROMPTON R.I. QUADRANGLE MAP WAS ASSUMED TO BE THE N.G.V.D. ELEVATION OF THE TOP OF THE STOP PLANKS. ALL OTHER ELEVATIONS SHOWN ARE REFERENCED TO THE ASSUMED TOP OF STOP PLANKS ELEVATION.

CAHN ENGINEERS INC. WALLINGFORD, CONNECTICUT ENGINEER	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS
PLAN, ELEVATION & SECTION

ARCTIC DAM

S. BRANCH PAWTUXET RIVER — WEST WARWICK, R.I.

DRAWN BY	CHECKED BY	APPROVED BY	SCALE AS NOTED	
R.F.	TJS	FMH	DATE: DEC. 1980	SHEET B-1

SUMMARY OF DATA AND CORRESPONDENCE

DATE	TO	FROM	SUBJECT	PAGE
Mar. 27, 1946	File	J. V. Keily R. I. Dept. of Public Works Division of Harbors and Rivers	Inspection Report	B-2
Feb. 1948	File	Division of Harbors and Rivers	Hydraulic/Hydrologic Date	B-3
Sept. 11, 1978	File	Earle F. Prout, Jr. R.I. Dept. of Environmental Manage-ment	Inspection Report	B-5

R. I. DEPARTMENT OF PUBLIC WORKS
DIVISION OF HARBORS AND RIVERS

SPECIAL INSPECTION REPORT

DAM NO. 148

INSPECTED BY J. V. KEILY

TOWN - WEST WARWICK

ON ~~BROOK~~ RIVER ~~TRENCH~~ PAWTUXET RIVER

WATERSHED PAWTUXET S B

45 NAME ARCTIC
Now owned - Mill
~~WESTOVER FABRIC CO.~~
West Warwick, R. I., TEL. ~~VAL. 0004~~ Va 1-0004

NEW CONSTRUCTION

REPAIRS

INSPECTION ONLY X

APPROVED

CONTRACTOR

INSPECTION REPORT BY J. V. KEILY REASON ROUTINE

DATE 3/27/46

EMERGENCY:

1. ~~CHARLES H. NELSON, MASTER MECHANIC, 11 BURNS ST., NATICK, TEL. VAL. 1272-R~~
2. WILLIAM JENNINGS, SUPT., ~~POTTER AVE.~~, 36 Bruce Lane Cowesett WEST WARWICK, R. I. Gr. 3142
3. ~~HARRY SIGOON, OFFICE MANAGER~~ Larry St Jean, Pascoag Res Tel. Pa 8233

ON

GATES

CONDITION GOOD. HEAVY GRANITE SPILLWAY BETWEEN MASSIVE GRANITE ABUTMENTS SPANS ENTIRE RIVER. TRENCH ON EAST SIDE OF RIVER LEADS TO WATER WHEELS IN MILL AND IS CONTROLLED BY TWO SETS OF GATES (ALL IN GOOD OPERATING CONDITION - REPAIRED 1945). 29" PERMANENT FLASH BOARD NOW IN PLACE (WOODEN WITH IRON SUPPORTS). TWO WHEELS AVAILABLE FOR POWER CAN DEVELOP 500 H.P. ONE NEW IN 1940. DAM UNDER CONSTANT SUPERVISION OF MASTER MECHANIC AND ~~RIVER~~ GAGE READ EVERY HOUR DAILY FROM 7 A. M. TO 11 P. M.

ON

& WHEELS

NT

8/9/48

REQUEST FROM ATTY. BULMAN FOR ARTISTIC FOUNDATION CO. (AT RIVERPOINT FINISHING CO. PLANT, NEXT BELOW - #147) AS TO OUR KNOWLEDGE OF A BREAK IN FLASH BOARD AT WESTOVER #148 ON MARCH 2, 1947, CAUSING LOSS OF CONSIDERABLE CLOTH AND FLOODING OF THEIR MILL. THIS OFFICE HAD RECEIVED NO NOTICE OF THIS FAILURE.

ON

HES

& TREES

SE

ROLS

ACTED
E

ONS LEFT

GENCY
L

DIVISION OF HARBORS AND RIVERS

SURVEY OF DAMS IN RHODE ISLAND

Pawtuxet River Basin (South Branch) **#148 Arctic**

Drainage Area 73.4 Sq. Mi.

February 1948

Spillway ?

Estimated extreme freshet 4844 c.f.s.

FEBRUARY 1948

Dam Name	Arctic (Factory St.)	Riverpoint Upper	Riverpoint Lower
Dam No.	148	147	146
Area of Watershed (nearest 1/10 sq. mi.)	73.4	73.7	73.8
Peak Discharge Rate of Watershed (CFS)	4894	4864	4761
Elevation Normal Water Level of Pool (Ft.)	108.0		
Area of Pool Surface (nearest acre)	14	6	4
Elevation Crest of Spillway (Ft.)	110.5	79.1	57.3
Max. Safe Depth of Flow over Spillway (Ft.)			5.0
Width of Spillway (Ft.)	100	120	100
Max. Flow Capacity of Spillway (CFS)			3900
Max. Storm Discharge Capacity (CFS)			5894
Structural Height (Ft.)	27		
Hydraulic Height (Ft.)	24		
Impounding Capacity (Max.)	194 acre-ft.		
Impounding Capacity (Normal)	173 acre-ft.		
Width of Drawoff (Ft.)	20	40	40
Number of Wheels	2	1	
Drop in Wheel (Ft.)	28	22	
Power Developed	500 H.P.	350-400 KW	
Height of Dam from River Bed (Ft.)	29		5
Elevation Normal Water Level Below Dam			50 ft.

DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

DAM INSPECTION REPORT

RIVER: Pawtuxet R/South WATERSHED: Pawtucket DATE: 11 September 1978

Arctic Pond Dam TOWN: West Warwick INSPECTED BY: Earle F. Prout, Jr.

Arctic Development Corp.
33 Factory Street
West Warwick, RI

OTHER INTERESTED PARTY: Natco Products Corp.
c/o Arctic Development Corp.

Dam Inspection:

* *

General: Dam built in 1885 for industrial power use.

Current Pool Elevation: 2" above crest of spillway.

Dam Embankment: The spillway spans the entire width of river with mill buildings on both sides.

Outlet: Draw-off; located on left (west) side of spillway, "rack and pinion" type gear mechanism is currently intact and although its operability was not tested, it appears to be mechanically sound. The rack timber is beginning to show signs of age, and its replacement is suggested (photo 2).

Sluiceway Gates: Located on right (east) side of spillway has been completely filled in - date unknown. The approach to the draw-off gates is clear and unobstructed. The outlet is through a large (3'$\pm$) metal pipe discharging back into river directly below spillway. There is presently a small amount of water flowing from the outlet structure indicating that the gate is slightly open (or leaking).

Spillway: The approach to the spillway is clear and unobstructed. There are no visible deficiencies across the crest of the spillway. The spillway is constructed of heavy granite block with stepped masonry face (photo #1). The stability of the crest and face was undetermined because of the full flow conditions; however, there were no visible deficiencies noted to warrant any doubt as to its structural integrity.

The heavy masonry abutment walls on both sides of the spillway appear to be structurally sound. However, there is a heavy growth of brush and shrubs on the left side which should be removed. The spillway discharge is clear and unobstructed.

Findings/Recommendations: The spillway structure appears to be in generally good condition. It is recommended, however, that the owner investigate the possible leaking condition of the draw-off gate and repair if necessary - along with the replacement of the rack timber. Also, removal of brush and shrubs from the top of the left abutment is suggested.

APPENDIX C

DETAIL PHOTOGRAPHS

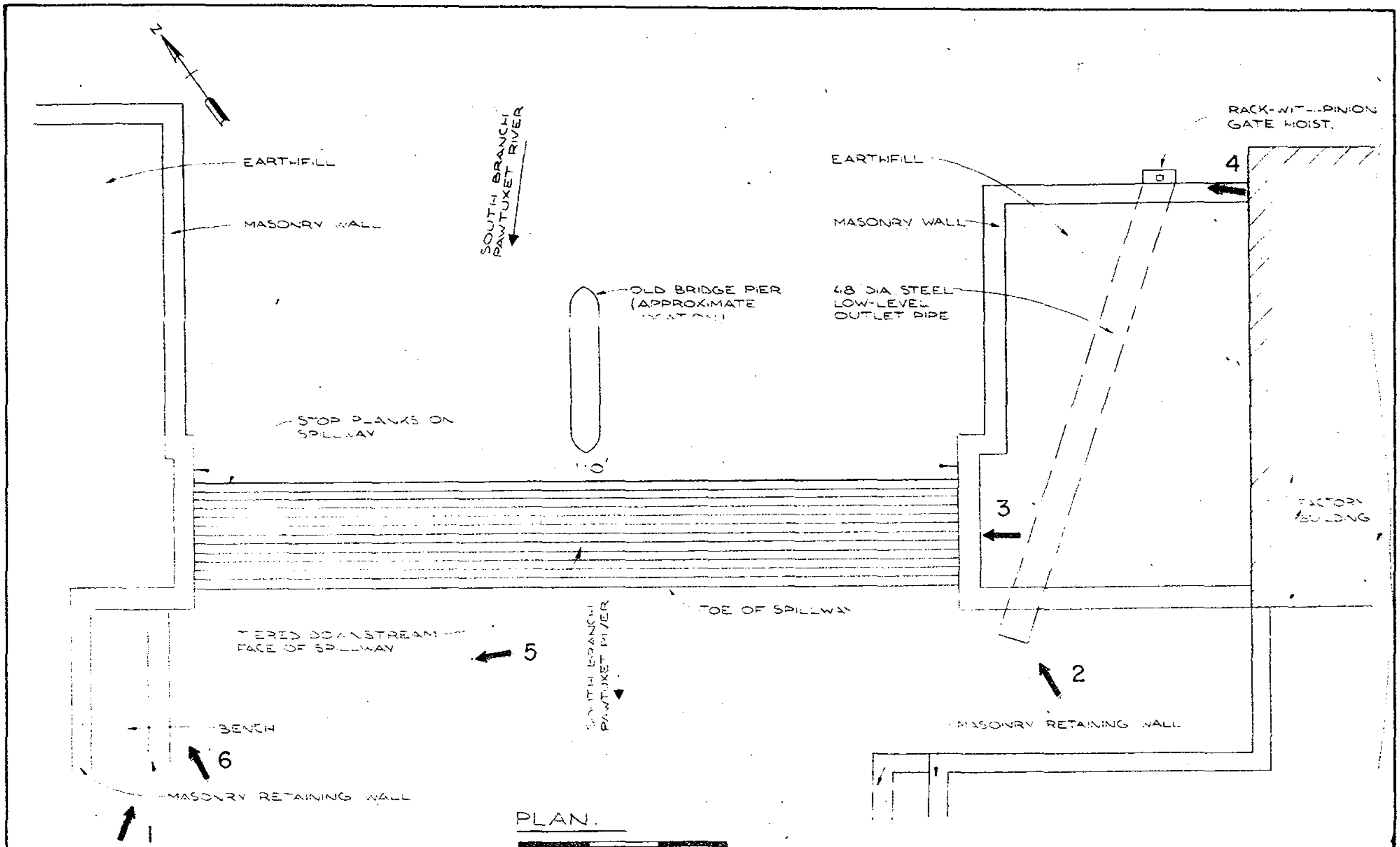


PHOTO LOCATION PLAN

ARCTIC DAM

SHEET C-1

Photo 1 - Right non-overflow section of dam and adjacent factory building (10/8/80).

Photo 2 - Downstream end of low-level outlet pipe. Note deterioration of pipe and leached-out mortar joints on wall (10/8/80).

US ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.	NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS	Arctic Dam S. Br. Pawtuxet River W. Warwick, R.I.
CAHN ENGINEERS INC. WALLINGFORD, CONN. ENGINEER		CE# 27 785 KG DATE Jan. '81 PAGE C-1

Photo 3 - Downstream face of spillway, spillway crest with permanent stop planks, and bridge pier in approach channel (10/8/80).

Photo 4 - Rack-with-pinion gate hoisting mechanism (10/8/80).

US ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.	NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS	Arctic Dam S. Br. Pawtuxet River W. Warwick, R.I.
CAHN ENGINEERS INC. WALLINGFORD, CONN. ENGINEER		CE# 27 785 KG DATE Jan. '81 PAGE C-2

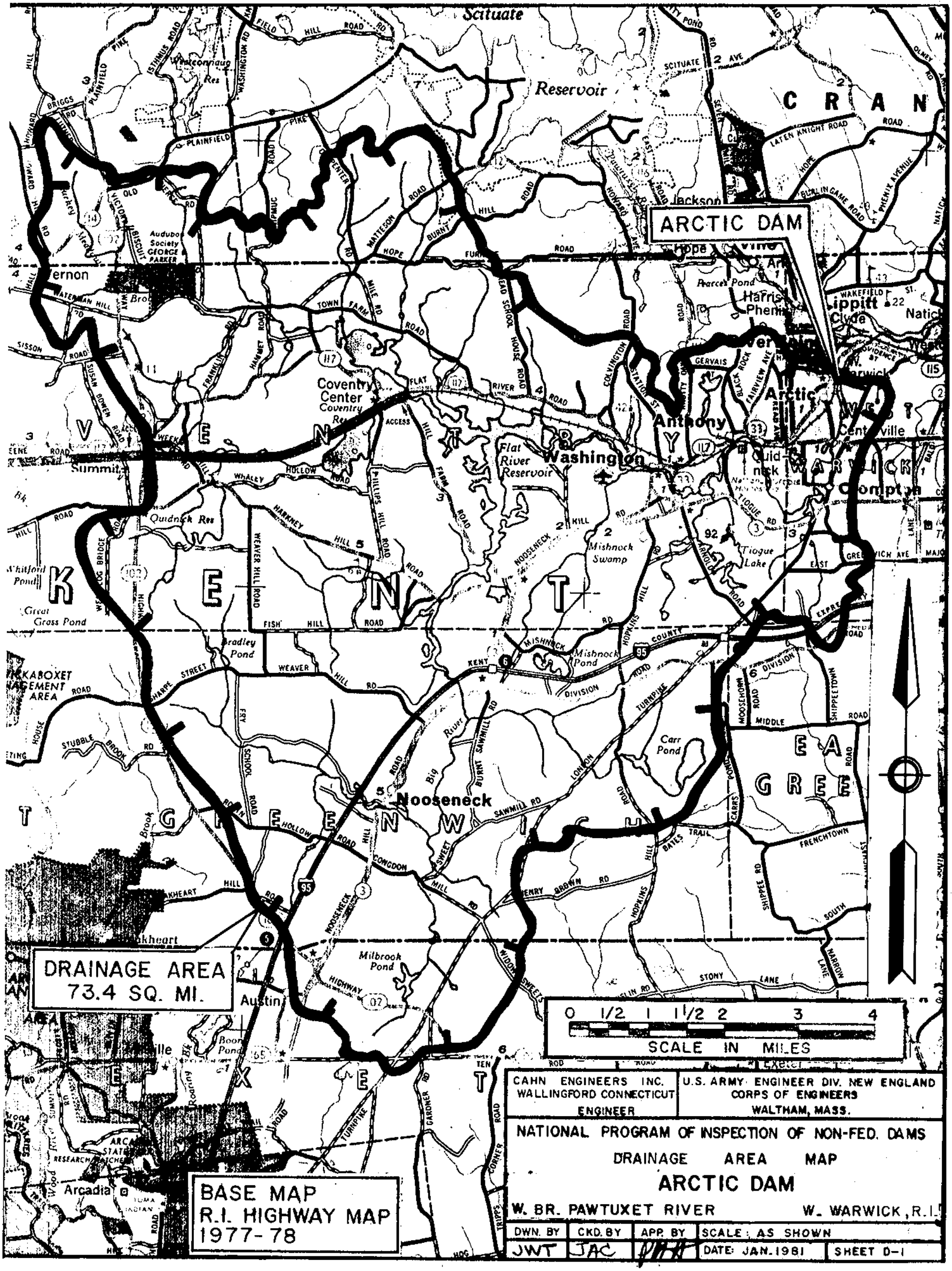
Photo 5 - Benched channel bank retaining wall between arch bridge at left and dam at right (10/8/80).

Photo 6 - Undermining at base of retaining wall. Note depth of flow and pattern of current under wall (10/8/80).

US ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.	NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS	Arctic Dam S. Br. Pawtuxet River W. Warwick, R.I. CE# 27 785 KG DATE Jan. '81 PAGE C-3
CAHN ENGINEERS INC. WALLINGFORD, CONN. ENGINEER		

APPENDIX D

HYDRAULICS/HYDROLOGIC COMPUTATIONS



CAHN ENGINEERS INC. WALLINGFORD CONNECTICUT ENGINEER	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

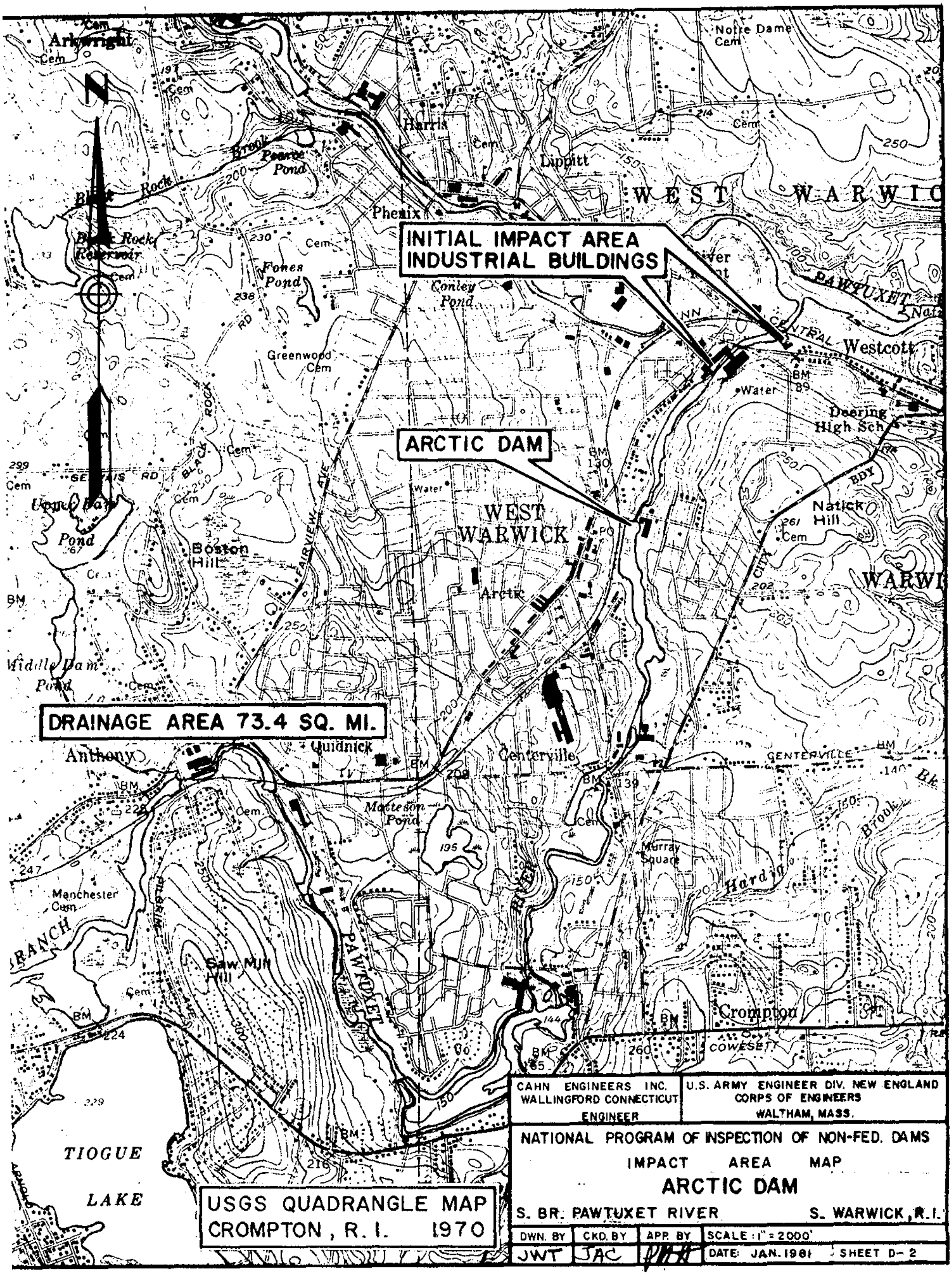
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

DRAINAGE AREA MAP

ARCTIC DAM

W. BR. PAWTUXET RIVER — W. WARWICK, R.I.

DWN. BY	CKD. BY	APP. BY	SCALE: AS SHOWN	
JWT	JAC	[illegible]	DATE: JAN. 1981	SHEET D-1


INITIAL IMPACT AREA
INDUSTRIAL BUILDINGS
ARCTIC DAM
DRAINAGE AREA 73.4 SQ. MI.
USGS QUADRANGLE MAP
CROMPTON, R. I. 1970
Arkwright
Harris
Lippitt
Phenix
WEST WARWICK
Pawtuxet
Westcott
Black Rock Reservoir
Fones Pond
Conley Pond
Greenwood Cem
Boston Hill
Natick Hill
Arctic
Quidnick
Anthony
Centerville
Matteson Pond
Murray Square
Manchester Cem
Saw Mill Hill
Crompton
TIOGUE LAKE
CAHN ENGINEERS INC.
WALLINGFORD CONNECTICUT
ENGINEER
U.S. ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS
IMPACT AREA MAP
ARCTIC DAM
S. BR. PAWTUXET RIVER
S. WARWICK, R.I.
DWN. BY
JWT
CKD. BY
JAC
APP. BY
SCALE: 1" = 2000'
DATE: JAN. 1981
SHEET D-2

Cahn Engineers Inc. **Consulting Engineers**

Project INSPECTION OF NON-FEDERAL DAMS IN NEW ENGLAND Sheet D-1 of 10
Computed By HLL Checked By GAB Date 10/30/80
Field Book Ref. Other Refs. CE#27-785-HB Revisions

HYDROLOGIC/HYDRAULIC INSPECTION

ARCTIC DAM, WEST WARWICK, R.I.

I) PERFORMANCE AT PEAK FLOOD CONDITIONS:

1) PROBABLE MAXIMUM FLOOD (PMF)

a) WATERSHED CLASSIFIED AS "FLAT AND COASTAL", TYPICALLY CONTAINING LARGE SWAMPS AND IMPOUNDMENS (TIOGUE LAKE, STUMP POND AND FLAT RIVER AND QUIDNIK RESERVOIRS)

b) WATERSHED AREA: D.A. = 73.4 SQMI

NOTE: D.A. FROM R.I. DEPARTMENT OF PUBLIC WORKS, DIV. OF HARBORS AND RIVERS "SURVEY OF DAMS IN RHODE ISLAND" - DAM #148 - C.E. APPROX. CHECK, D.A. = 71.4 SQMI.

c) PEAK FLOODS (FROM NED-ACE GUIDELINES - GUIDE CURVES FOR PMF):

i) FROM GUIDE CURVES. CSM = 450 CFS/SQMI

ii) PMF ≈ 73.4 × 450 = 33000 CFS

iii) ½ PMF ≈ 16500 CFS

2) SURCHARGE AT PEAK INFLOWS (PMF AND ½ PMF)

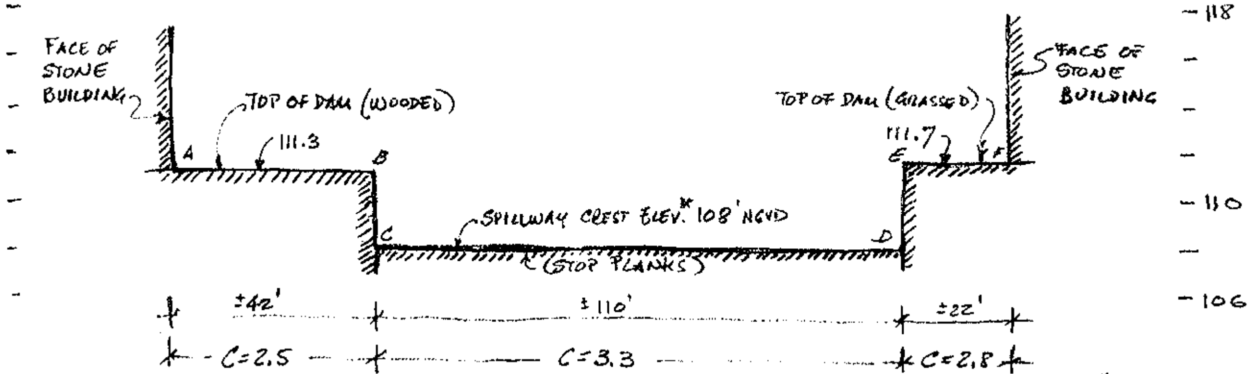
a) OUTFLOW RATING CURVE:

i) SPILLWAY AND OVERFLOW PROFILE OF DAM:

STONE MASONRY SPILLWAY (±) 110' LONG WITH STOP PLANKS (TOP ELEV.* 108' NGVD), STONE MASONRY AND EARTH FILL ABUTMENTS AT BOTH SIDES OF SPILLWAY TO ADJACENT STONE BUILDINGS WHICH CLOSE THE OVERFLOW SECTION (SEE PROFILE, p. D-2)

*NOTE: W.S. ELEVATION 108' MSL ON THE USGS CROMPTON, R.I. QUADRANGLE SHEET (REV. 1970) IS ASSUMED TO BE TOP OF STOP PLANKS ELEVATION ON NATIONAL GEODETIC VERTICAL DATUM (NGVD).

ASSUME C=3.3 FOR THE SPILLWAY (STOP PLANKS), AND C=2.8 AND C=2.5 FOR THE RIGHT & LEFT ABUTMENTS' OVERFLOW.



*SEE NOTE ON P. D-1

NOTE: DATA FROM C.E. OBSERVATIONS ON 10/8/80 BY HLL, F.S. & T.S.

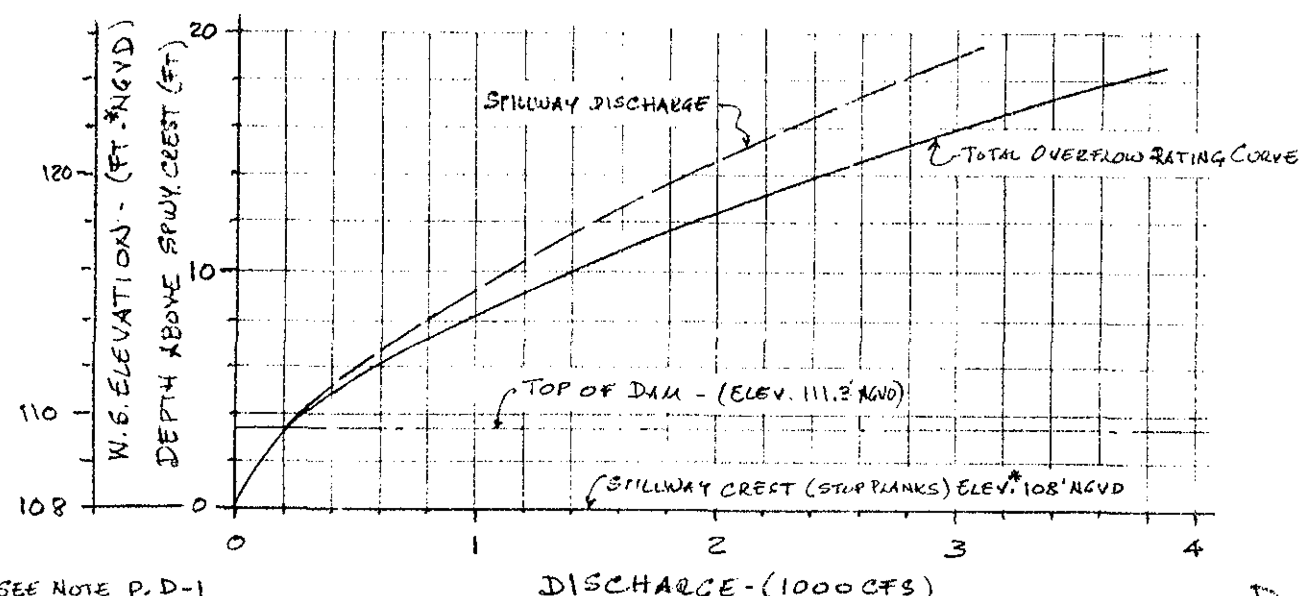
ARCTIC DAM
APPROXIMATE OVERFLOW PROFILE

ii) THE OVERFLOW RATING CURVE CAN BE APPROXIMATED BY THE EQUATION:

$$Q = 363\,H^{3/2} + 105\,(H-3.3)^{3/2} + 61.6\,(H-3.7)^{3/2} \qquad (Q = Q_{CD} + Q_{AB} + Q_{EF})$$

WHERE "H" IS THE SURCHARGE ABOVE THE SPILLWAY CREST (TOP OF STOP PLANKS)

iii) ARCTIC DAM - OUTFLOW RATING CURVE



*SEE NOTE P. D-1

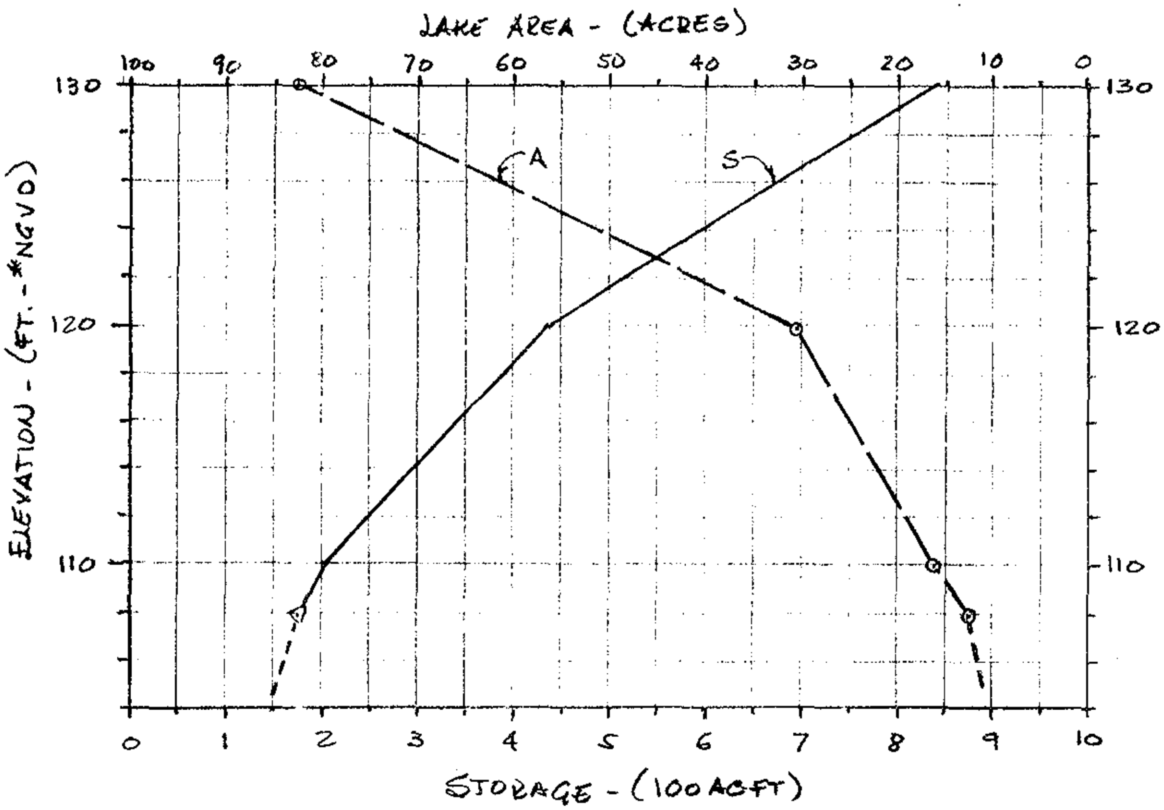
b) SURCHARGE DEPTHS TO PASS PEAK INFLOWS (Q_{P_1} & Q'_{P_1})

i) @ $Q_{P_1} \doteq$ PMF = 33000 CFS $H_1 \doteq$ 16.8'

ii) @ $Q'_{P_1} \doteq$ ½ PMF = 16500 CFS $H'_1 \doteq$ 10.9'

c) EFFECT OF SURCHARGE - PEAK OUTFLOWS.

i) LAKE AREA / STORAGE RATING CURVES - ARCTIC DAM



△ - DATA FROM R.I. DEPT. OF PUBLIC WORKS - DIV. OF HARBORS & RIVERS - (TABULATION FOR DAM # 148)
ALSO, ON ACE U.S. INVENTORY OF DAMS, - (NORMAL STORAGE: S = 173 AC-FT - ASSUMED TO ELEV. 108 NGVD)
⊙ - AREAS MEASURED ON USGS CROMPTON, R.I. QUADRANGLE SHEET (REV. 1970)
* - SEE NOTE P. D-1

ahn Engineers Inc. **Consulting Engineers**

ct NON-FEDERAL DAMS INSPECTION Sheet D-4 of 10

uted By HLL Checked By GAB Date 11/7/80

Book Ref. Other Refs. CE#27-785-HB Revisions

ii) WATERSHED D.A. $\approx$ 73.4 sq mi (SEE P. D-1)

iii) PEAK OUTFLOWS (Q_{P_3} & Q'_{P_3})

BECAUSE THE LAKE AREA AND CONSEQUENTLY, THE SURCHARGE STORAGE OF ARCTIC DAM ARE TOO SMALL TO HAVE AN APPRECIABLE EFFECT IN THE REDUCTION OF THE PEAK INFLOW, THE PEAK OUTFLOWS ARE APPROXIMATELY,

$Q_{P_3} \approx Q_{P_1} = 33000^{\text{CFS}}$ $H_3 \approx \underline{16.8'}$

$Q'_{P_3} \approx Q'_{P_1} = 16500^{\text{CFS}}$ $H'_3 \approx \underline{10.9'}$

3) SPILLWAY CAPACITY RATIO TO PEAK OUTFLOWS.

SPILLWAY CAPACITY TO:	SURCH.* H (FT)	W.S. ELEV.⊕ (FT. NGVD)	SPILLWAY CAPACITY⊕ (CFS)	SPILLWAY CAPACITY AS % OF PEAK OUTFLOWS	
				Q_{P_3} (33000 CFS)	Q'_{P_3} (16500 CFS)
TOP OF DAM**	3.3	111.3	2200	6.7	13
½ PMF	10.9	118.9	13100	—	79
PMF	16.8	124.8	25000	76	—

*SURCHARGE ABOVE SPILLWAY CREST (TOP OF STOP PLANKS ELEV. 108' NGVD)

** TOP OF DAM AT LOW POINT (LEFT ABUTMENT) - ELEV. ±111.3' NGVD

⊕ ASSUMES NO COLLAPSE OF STOP PLANKS OR ADJACENT BUILDINGS. (MASONRY SPILLWAY CREST @ (±) ELEV. 106' NGVD OR $Q'_S \approx 4200$ CFS TO TOP OF DAM W/O STOP PLANKS)

Cahn Engineers Inc. Consulting Engineers

Project NON-FEDERAL DAMS INSPECTION Sheet D-5 of 10
Computed By HM Checked By GAB Date 11/7/80
Field Book Ref. Other Refs. CE #27-785-HB Revisions

ARCTIC DAM

II) DOWNSTREAM FAILURE HAZARD

1) POTENTIAL IMPACT AREA.

TWO LARGE INDUSTRIAL BUILDINGS ARE LOCATED ON THE SOUTH BRANCH OF THE PAWTUXET RIVER (±)2500' AND (±)3900', RESPECTIVELY, D/S FROM ARCTIC DAM. TWO OTHER DAMS (RI #147 AND #146) LOCATED NEAR THESE BUILDINGS, IMPOUND WATER TO NORMAL LEVELS (±)5' BELOW THE FIRST FLOORS OF THE BUILDINGS SECTIONS ON THE U/S SIDE OF THESE RESERVOIRS. THE BUILDING'S SECTIONS D/S FROM THE DAMS, ARE (±)7' AND 11' RESPECTIVELY, ABOVE THE WATER LEVEL OF RES. #146 AND THE RIVER CHANNEL D/S FROM THE DAMS. THESE STRUCTURES CONSTITUTE THE POTENTIAL IMPACT AREA IN CASE OF FAILURE OF ARCTIC DAM.

2) FAILURE AT ARCTIC DAM

ASSUME SURCHARGE TO TOP OF DAM, ELEV. 111.3' NGVD

a) HEIGHT OF DAM *: $H_{max} \simeq 30'$ (TOE OF DAM @ RIGHT ABUTMENT * ELEV. 83.2' NGVD
∴ ASSUME STREAMBED AT D/S FACE (±) ELEV. 82' NGVD ∴ $H \simeq 111.7 - 82 = 29.7'$ say 30')

b) MID-HEIGHT LENGTH * : $\ell \simeq 155'$

c) BREACH WIDTH (SEE NED-ACE D/S DAM FAILURE GUIDELINES)

$W = 0.4 \times 155 = 62'$ ∴ ASSUME $W_b = \underline{\underline{62'}}$

d) ASSUMED WATER DEPTH AT TIME OF FAILURE: $y_0 \simeq \underline{\underline{29.3'}}$ (TO FIRST PT. OF OVER-TOPPING, EL. 111.3' NGVD)

e) SPILLWAY DISCHARGE AT TIME OF FAILURE:

i) PREVIOUS TO FAILURE: $Q_s = 2200^{cfs}$ (SEE P. D-4)
ii) AFTER FAILURE (ASSUMED REMAINING SPWY. $L_s' \simeq 90'$); $Q_s' \simeq 1800^{cfs}$

*FROM CE MEASUREMENTS ON 10/8/80 BY HM, T.S. & F.S.

f) BREACH OUTFLOW (SEE NED-ACE GUIDELINES):

$$Q_b = \frac{8}{27} W_b \sqrt{g}\, Y_o^{3/2} \doteq \underline{16500}^{CFS}$$

g) PEAK FAILURE OUTFLOW (Q_{P_1}) TO S. BRANCH PAWTUXET RIVER:

$$Q_{P_1} = Q_s' + Q_b \doteq \underline{\underline{18300}}^{CFS}$$

3) FLOOD DEPTH * IMMEDIATELY D/S FROM DAM:

$$Y_1 \doteq 0.44\, Y_o = \underline{\underline{12.9'}}$$

*(FROM RETREATING WAVE THEORY APPLIED TO DAM FAILURE)

4) ESTIMATE OF D/S FAILURE CONDITIONS AT POTENTIAL IMPACT AREA:

(SEE NED-ACE GUIDELINES FOR ESTIMATING D/S FAILURE HYDROGRAPHS)

a) THE W.L. IN THE (±)3000' LONG REACH OF S.BR. PAWTUXET RIVER D/S FROM THE DAM TO THE POTENTIAL IMPACT AREA IS CONTROLLED BY TWO DAMS* (R.I. #147 & #146). R.I. DAM #147 (UPPER RIVER POINT) HAS A (±) 120' LONG SPILLWAY AND IS LOCATED (±) 2500' D/S FROM ARCTIC DAM. THE LAKE IS (±) 100' WIDE (AVE.) AND THE SIDE (CHANNEL) BANKS SLOPE AT (±) 3H TO 1V; SPILLWAY CREST (±) ELEV. 79' (NGVD). R.I. DAM #146 (LOWER RIVER POINT) HAS A (±) 100' LONG SPILLWAY AT (±) ELEV. 57' (NGVD). THE TOP OF DAM IS (±) 5' ABOVE THE SPILLWAY CREST AND IF OVERTOPPED, WILL ADD (±) 80' HORIZONTALLY TO THE OVERFLOW PROFILE. THE LAKE IS (±) 120' WIDE (AVE.) AND EXTENDS (±) 1400' TO THE U/S DAM (RI. #147).-

b) RESERVOIR STORAGE AT TIME OF FAILURE:

$$S_{MAX} \doteq \underline{\underline{230}}^{AC\text{-}FT} \qquad (\text{SEE P. D-3})$$

*DATA FROM R.I. DEPT. OF PUBLIC WORKS - DIV. OF HARBORS & RIVERS - TABULATION FOR DAMS #147 & #146 AND C.E. FIELD OBSERVATIONS ON 10/8/80

C) APPROXIMATE STAGE AT POTENTIAL IMPACT AREA AFTER FAILURE.

i) 1ST REACH: D/S FROM R.I. DAM #147

ASSUME OVERFLOW APPROX. EQUAL TO SPILLWAY AND $C \cong 3.2$.
ASSUME AVE. LAKE AREA ($\bar{A}$) WITHIN THE EXPECTED MAX. SURCH. (±13'), EQUAL TO: $\bar{A} \cong 140 \times 2500 = 350000^{SQ FT} \cong \underline{8}^{AC}$

∴ THE TOTAL OVERFLOW FROM R.I. DAM #147 IS APPROXIMATED BY:

$$Q_{(147)} \cong 384 H^{3/2}$$

AND, APPROXIMATE ROUTING (SEE NED-ACE GUIDELINES) OF THE PEAK FAILURE OUTFLOW GIVES:

$$(Q_{p_3})_1 \cong Q_{p_1}\left(1 - \frac{V_3}{S}\right) \cong \underline{\underline{12000}}^{CFS} \quad ; \quad (H_3)_1 \cong 9.9' \text{ (D/S RI DAM \#147)}$$

ii) 2ND REACH D/S FROM R.I. DAM #146

ASSUME $C = 3.2$ AND $C = 2.8$ FOR THE SPILLWAY FLOW AND DAM/ADJACENT TERRAIN OVERFLOW.-
ASSUME AVE. LAKE AREA ($\bar{A}$) WITHIN THE EXPECTED SURCHARGE $\bar{A} \cong 150 \times 1400 = 210000^{SQ FT} \cong \underline{\underline{4.8}}^{AC}$

∴ THE TOTAL OVERFLOW FROM R.I. DAM #146 IS APPROXIMATED BY:

$$Q_{(146)} \cong 320 H^{3/2} + 224 (H-5)^{3/2}$$

APPROXIMATE ROUTING OF THE PEAK OUTFLOW ($(Q_{p_1})_2 = 12000^{CFS}$) GIVES:

$$(Q_{p_3})_2 \cong \underline{\underline{9800}}^{CFS} \qquad (H_3)_2 \cong \underline{\underline{8.7}}' \text{ (D/S R.I. DAM \#146)}$$

d) APPROXIMATE STAGE BEFORE FAILURE D/S FROM ARCTIC DAM:

i) 1ST REACH: $(H_S)_1 \doteq 3.2'$ ($Q_S \doteq 2200$ CFS, SEE P. D-5)

ii) 2ND REACH: $(H_S)_2 \doteq 3.6'$ (DAM NOT OVERTOPPED @ $Q_S = 2200$ CFS)

e) RAISE IN STAGE D/S FROM ARCTIC DAM:

i) 1ST REACH: $(\Delta H)_1 \doteq 6.7'$ (D/S FROM R.I. DAM #147)

ii) 2ND REACH: $(\Delta H)_2 \doteq 5.1'$ (D/S FROM R.I. DAM #146)

Cahn Engineers Inc. Consulting Engineers

Project NON-FEDERAL DAMS INSPECTION Sheet D-9 of 10
Computed By [illegible] Checked By GAB Date 11/11/80
Field Book Ref. Other Refs. CE #27-785-HB Revisions

ARCTIC DAM

III) SELECTION OF TEST FLOOD

1) CLASSIFICATION OF DAM ACCORDING TO NED-ACE GUIDELINES:

a) SIZE: * STORAGE (MAX) $\approx$ 230 $^{AC\text{-}FT}$ ($50 < S < 1000^{AC\text{-}FT}$)
* HEIGHT $\approx$ 30' ($25 < H < 40^{FT}$)

*STORAGE: SEE p. D-3; HEIGHT: SEE p. D-5

∴ SIZE CLASSIFICATION: SMALL

b) HAZARD POTENTIAL: AS A RESULT OF THE D/S FAILURE ANALYSIS AND IN VIEW OF THE IMPACT THAT FAILURE OF ARCTIC DAM MAY HAVE ON THE POTENTIAL IMPACT AREA (p. D-5), THE DAM IS CLASSIFIED AS HAVING:

HAZARD CLASSIFICATION: HIGH

2) TEST FLOOD: 1/2 PMF = 16500 ^{CFS}

THIS SELECTION IS BASED ON THE RESULTS OF THE PREVIOUS ANALYSIS AND CLASSIFICATION.

ARCTIC DAM

IV) SUMMARY

1) TEST FLOOD = ½ PMF ≈ 16500 CFS
(PARALLEL COMPUTATIONS HAVE BEEN MADE FOR PMF ≈ 33000 CFS AND ARE ALSO SUMMARIZED BELOW)

2) PERFORMANCE AT PEAK FLOOD CONDITIONS:

a) PEAK INFLOWS: Q_{P_1} = PMF ≈ 33000 CFS Q'_{P_1} = ½ PMF ≈ 16500 CFS
b) PEAK OUTFLOWS: Q_{P_3} ≈ Q_{P_1} = 33000 CFS Q'_{P_3} ≈ Q'_{P_1} = 16500 CFS
c) SPILLWAY CAPACITY: (SEE TABLE p. D-4)
d) PERFORMANCE:
i) AT TEST FLOOD: OVERTOPPED (±) 7.6' (W.S. ELEV. 118.9' NGVD)
ii) AT PMF: OVERTOPPED (±) 13.5' (W.S. ELEV. 124.8' NGVD)

3) DOWNSTREAM FAILURE CONDITIONS:

a) PEAK FAILURE OUTFLOW: Q_{P_1} = 18300 CFS
b) FLOOD DEPTH IMMEDIATELY D/S FROM DAM: Y_0 ≈ 12.9'
c) CONDITIONS U/S FROM R.I. DAM #147:
i) STAGE BEFORE FAILURE H_S ≈ 3.2' ABOVE NORMAL POOL (Q_S ≈ 2200 CFS)
ii) STAGE AFTER FAILURE H_3 ≈ 9.9' ABOVE NORMAL POOL (Q_3 ≈ 12000 CFS)
iii) RAISE IN STAGE AFTER FAILURE: ΔH ≈ 6.7'
d) CONDITIONS U/S FROM R.I. DAM #146:
i) STAGE BEFORE FAILURE H_S ≈ 3.6' ABOVE NORMAL POOL (Q_S ≈ 2200 CFS)
ii) STAGE AFTER FAILURE H_3 ≈ 8.7' ABOVE NORMAL POOL (Q_3 ≈ 7800 CFS)
iii) RAISE IN STAGE AFTER FAILURE: ΔH ≈ 5.1'

PRELIMINARY GUIDANCE

FOR ESTIMATING

MAXIMUM PROBABLE DISCHARGES

IN

PHASE I DAM SAFETY

INVESTIGATIONS

New England Division
Corps of Engineers

March 1978

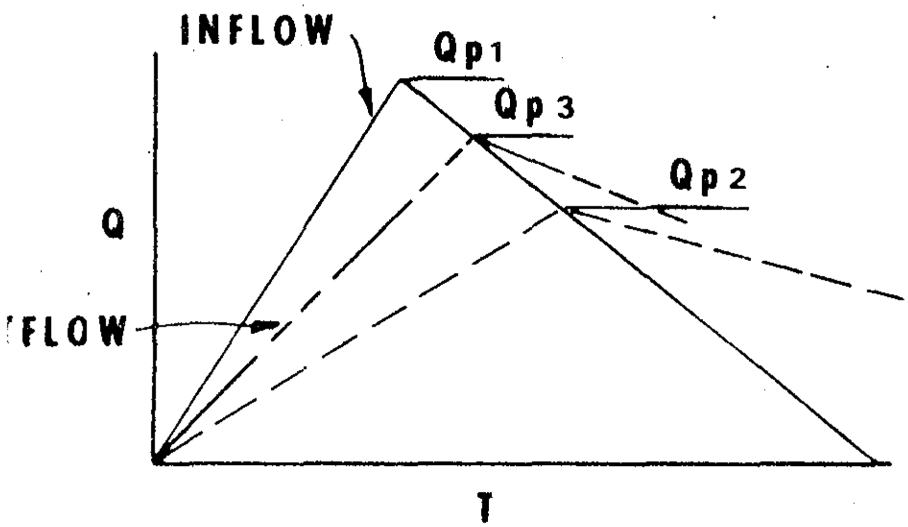
MAXIMJM PROBABLE FLOOD INFLOWS
NED RESERVOIRS

	Project	Q (cfs)	D.A. (sq. mi.)	MPF cfs/sq. mi.
1.	Hall Meadow Brook	26,600	17.2	1,546
2.	East Branch	15,500	9.25	1,675
3.	Thomaston	158,000	97.2	1,625
4.	Northfield Brook	9,000	5.7	1,580
5.	Black Rock	35,000	20.4	1,715
6.	Hancock Brook	20,700	12.0	1,725
7.	Hop Brook	26,400	16.4	1,610
8.	Tully	47,000	50.0	940
9.	Barre Falls	61,000	55.0	1,109
10.	Conant Brook	11,900	7.8	1,525
11.	Knightville	160,000	162.0	987
12.	Littleville	98,000	52.3	1,870
13.	Colebrook River	165,000	118.0	1,400
14.	Mad River	30,000	18.2	1,650
15.	Sucker Brook	6,500	3.43	1,895
16.	Union Village	110,000	126.0	873
17.	North Hartland	199,000	220.0	904
18.	North Springfield	157,000	158.0	994
19.	Ball Mountain	190,000	172.0	1,105
20.	Townshend	228,000	106.0(278 total)	820
21.	Surry Mountain	63,000	100.0	630
22.	Otter Brook	45,000	47.0	957
23.	Birch Hill	88,500	175.0	505
24.	East Brimfield	73,900	67.5	1,095
25.	Westville	38,400	99.5(32 net)	1,200
26.	West Thompson	85,000	173.5(74 net)	1,150
27.	Hodges Village	35,600	31.1	1,145
28.	Buffumville	36,500	26.5	1,377
29.	Mansfield Hollow	125,000	159.0	786
30.	West Hill	26,000	28.0	928
31.	Franklin Falls	210,000	1000.0	210
32.	Blackwater	66,500	128.0	520
33.	Hopkinton	135,000	426.0	316
34.	Everett	68,000	64.0	1,062
35.	MacDowell	36,300	44.0	825

MAXIMUM PROBABLE FLOWS
BASED ON TWICE THE
STANDARD PROJECT FLOOD
(Flat and Coastal Areas)

	River	SPF (cfs)	D.A. (sq. mi.)	MPF (cfs/sq. mi.)
1.	Pawtuxet River	19,000	200	190
2.	Mill River (R.I.)	8,500	34	500
3.	Peters River (R.I.)	3,200	13	490
4.	Kettle Brook	8,000	30	530
5.	Sudbury River.	11,700	86	270
6.	Indian Brook (Hopk.)	1,000	5.9	340
7.	Charles River.	6,000	184	65
8.	Blackstone River.	43,000	416	200
9.	Quinebaug River	55,000	331	330

ESTIMATING EFFECT OF SURCHARGE STORAGE ON MAXIMUM PROBABLE DISCHARGES



STEP 1: Determine Peak Inflow (Qp_1) from Guide Curves.

STEP 2: a. Determine Surcharge Height To Pass "Qp_1".

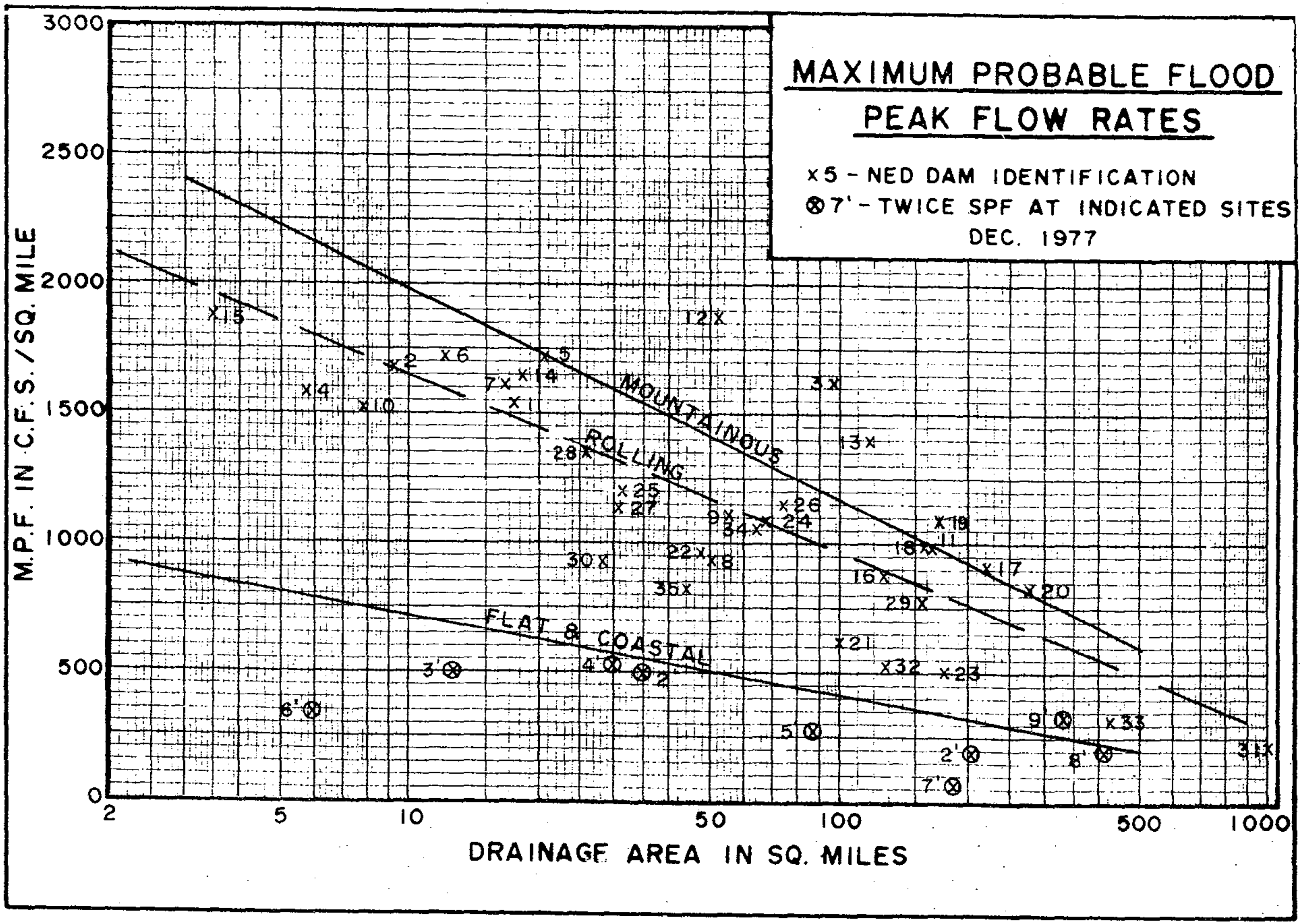
b. Determine Volume of Surcharge ($STOR_1$) In Inches of Runoff.

c. Maximum Probable Flood Runoff In New England equals Approx. 19", Therefore:

$$Qp_2 = Qp_1 \times \left(1 - \frac{STOR_1}{19}\right)$$

STEP 3: a. Determine Surcharge Height and "$STOR_2$" To Pass "Qp_2"

b. Average "$STOR_1$" and "$STOR_2$" and Determine Average Surcharge and Resulting Peak Outflow "Qp_3".


MAXIMUM PROBABLE FLOOD
PEAK FLOW RATES
x5 - NED DAM IDENTIFICATION
⊗7' - TWICE SPF AT INDICATED SITES
DEC. 1977
M.P.F. IN C.F.S./SQ. MILE
DRAINAGE AREA IN SQ. MILES
MOUNTAINOUS
ROLLING
FLAT & COASTAL
3000
2500
2000
1500
1000
500
0
2
5
10
50
100
500
1000

SURCHARGE STORAGE ROUTING SUPPLEMENT

STEP 3: a. Determine Surcharge Height and "$STOR_2$" To Pass "Qp_2"

b. Avg "$STOR_1$" and "$STOR_2$" and Compute "Qp_3".

c. If Surcharge Height for Qp_3 and "$STOR_{AVG}$" agree O.K. If Not:

STEP 4: a. Determine Surcharge Height and "$STOR_3$" To Pass "Qp_3"

b. Avg. "Old $STOR_{AVG}$" and "$STOR_3$" and Compute "Qp_4"

c. Surcharge Height for Qp_4 and "New $STOR_{Avg}$" should Agree closely

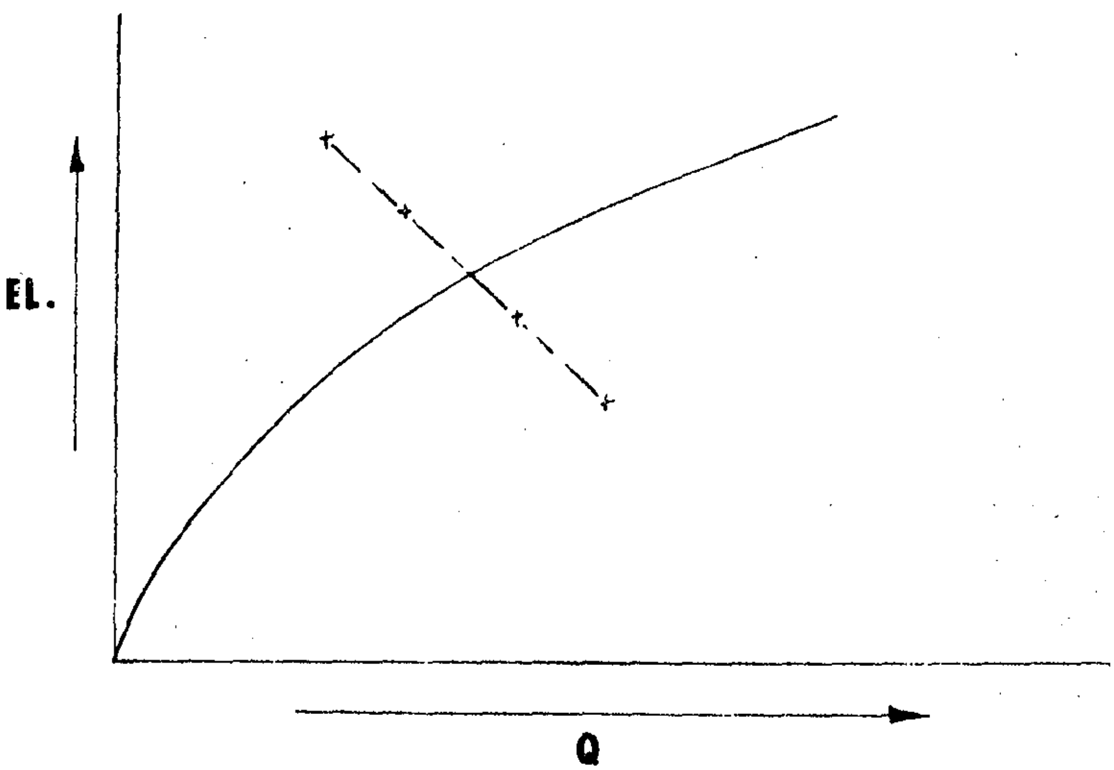
SURCHARGE STORAGE ROUTING ALTERNATE

$$Q_{p2} = Q_{p1} \times \left(1 - \frac{STOR}{19}\right)$$

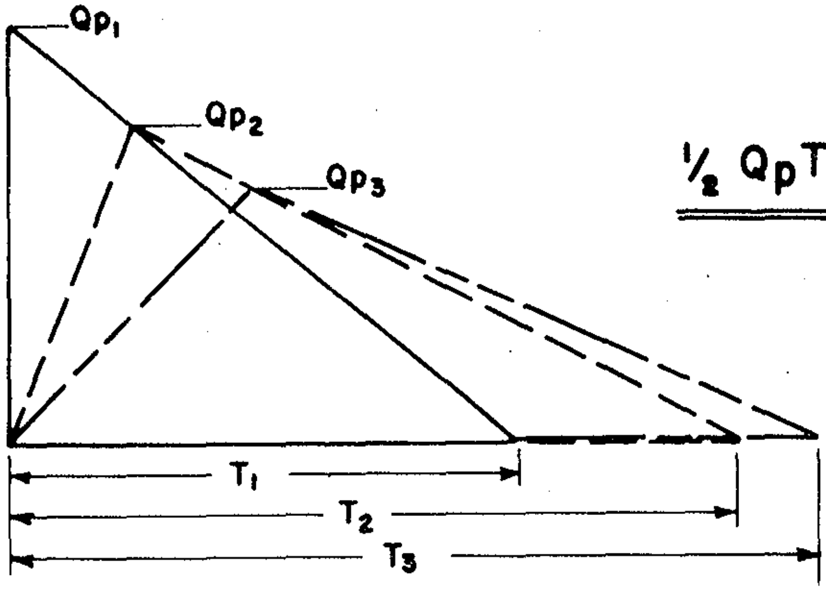
$$Q_{p2} = Q_{p1} - Q_{p1}\left(\frac{STOR}{19}\right)$$

FOR KNOWN Q_{p1} AND 19'' R.O.

Q_{p2}	STOR	EL.



"RULE OF THUMB" GUIDANCE FOR ESTIMATING DOWNSTREAM DAM FAILURE HYDROGRAPHS



$$\frac{1}{2} Q_p T = 12\,S$$

STEP 1: DETERMINE OR ESTIMATE RESERVOIR STORAGE (S) IN AC-FT AT TIME OF FAILURE.

STEP 2: DETERMINE PEAK FAILURE OUTFLOW (Q_{p1}).

$$Qp_1 = \frac{8}{27}\, W_b \sqrt{g}\; Y_o^{3/2}$$

W_b = BREACH WIDTH - SUGGEST VALUE NOT GREATER THAN 40% OF DAM LENGTH ACROSS RIVER AT MID HEIGHT.

Y_o = TOTAL HEIGHT FROM RIVER BED TO POOL LEVEL AT FAILURE.

STEP 3: USING USGS TOPO OR OTHER DATA, DEVELOP REPRESENTATIVE STAGE-DISCHARGE RATING FOR SELECTED DOWNSTREAM RIVER REACH.

STEP 4: ESTIMATE REACH OUTFLOW (Q_{p2}) USING FOLLOWING ITERATION.

A. APPLY Q_{p1} TO STAGE RATING, DETERMINE STAGE AND ACCOPMANYING VOLUME (V_1) IN REACH IN AC-FT. (NOTE: IF V_1 EXCEEDS 1/2 OF S, SELECT SHORTER REACH.)

B. DETERMINE TRIAL Q_{p2}.

$$Qp_2(\text{TRIAL}) = Qp_1\left(1 - \frac{V_1}{S}\right)$$

C. COMPUTE V_2 USING Q_{p2} (TRIAL).

D. AVERAGE V_1 AND V_2 AND COMPUTE Q_{p2}.

$$Qp_2 = Qp_1\left(1 - \frac{V_{AVG}}{S}\right)$$

STEP 5: FOR SUCCEEDING REACHES REPEAT STEPS 3 AND 4.

APRIL 1978

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS